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THE OLFACTORY SENSE OF LEPIDOPTEROUS LARVÆ.

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INTRODUCTION.

A thorough investigation of the above subject will undoubtedly throw some light upon how plants attract insects, because as yet no one has shown experimentally that lepidopterous larvæ can smell and the olfactory organs have never been described. Whenever it is proved that insect larvæ respond to chemical stimuli, and whenever organs suitable for the reception of these stimuli have been found, then we can intelligently ask why do the cotton caterpillar (*Alabama argillacea* Hübr.) and cotton boll weevil (*Anthonomus grandis* Boh.) feed exclusively on the cotton plant?; or why does the silkworm (*Bombyx mori* L.) feed almost exclusively on mulberry-tree leaves?. Many more similar examples could be given by any entomologist, but why is it that some larvæ are very selective in regard to their food while others show little or no preference between members of a large list of plants. Also, how does a female lepidopteron distinguish the best or only suitable host plant for her progeny so that she can deposit her eggs on this particular plant? The only plausible answer for all of these questions is to suppose that plants, as well as animals, emit odors, and that insects in searching for food, either for themselves or for their young progeny, are guided by the odors emitted by the plants. In order that the odors of plants may differ, it may also be assumed that the various chemical constituents of plants emit particular odors and that the odor emitted from a plant may be a combination of all the odors from the various constituents, or possibly one odor might be so strong that it masks all the others.

Upon this hypothesis, the odors from plants would vary according to the number, combination and quantitative percentages of the various constituents. Reasoning along this line of thought, we may be able to explain why a few insects have only one host plant; why many have a preferred host plant, but will eat other allied plants; and why others eat a large number of plants. If we could positively answer the above questions, we might be able to devise practical methods for the control of certain insects, as by trap baits, etc.

The present investigation will show that lepidopterous larvæ respond to chemical stimuli and that they have organs suitable for receiving these stimuli; and the following review of the literature will indicate how insects are attracted by certain host plants.

Verschaffelt (1910), experimenting with the cabbage-butterfly larvæ, *Pieris brassicæ* and *P. rapæ*, found that they are very fond of the cultivated species of the Cruciferæ and that in captivity they ate leaves from 15 indigenous species, representing 14 genera, of the same family. They did not eat all of these species, however, equally readily, and refused to eat species belonging to 17 other families, but did attack *Tropæolum* and *Reseda* which belong to two other families. Chemists have determined that all of the plants eaten by the above larvæ contain mustard oils. To determine whether these larvæ could be induced to eat leaves not ordinarily attacked, leaves of *Apios tuberosa* were smeared with the juice from the leaves of a crucifer (*Bunias orientalis*); these leaves were at once attacked and in a short time devoured. Wheat flour and corn starch, which when dry or moistened with water are rejected by both *Pieris-larvæ*, are eaten with avidity when soaked with *Bunias*-juice. The larvæ behave in a similar manner toward filter paper saturated with *Bunias*-juice.

To ascertain the exact constituent in the plants and juices which attracted the larvæ, Verschaffelt wet leaves of *Apios tuberosa* and *Rosa* (two species not containing mustard oil) with a fairly strong solution of pure sinigrin (potassium myronate), the glucoside of black mustard; these leaves were eagerly eaten by the larvæ. He says: "It is clear that *Pieris*-caterpillars seek out various mustard oils, just like the various glucosides derived from them. They are clearly attracted by the whole group of substances."

RESPONSE TO CHEMICAL STIMULI.

While feeding silkworms it is easy to determine that they can smell; this is done by placing fresh mulberry-tree leaves near them so that they can neither see nor touch the leaves; immediately the silkworms move their heads, work their mouth parts and begin crawling toward the leaves, and sometimes a hungry silkworm for several minutes will follow a leaf dragged slowly just in front of its head and the writer believes that the larva is guided solely by means of the odors emitted from the leaf rather than by seeing the leaf. Silkworms may also be induced to eat other leaves which they will not ordinarily even "taste." This was proved by the following test: Leaves from peach trees, cherry trees, plum trees, and apple trees were dipped into the juice from mulberry-tree leaves and were then fed wet to silkworms; all of these leaves were eaten, although some of them apparently were not really relished. When other leaves of the same trees were dipped into water, the silkworms did not even "taste" them.

To test the responses to other chemical stimuli the various larvæ used were confined in small observation cases and the sources of the odors were usually kept in small vials which were held directly beneath the larva in the case. The following larvæ were used in the experiments: Tent caterpillars, fall webworms, tussock-moth larvæ, army worms and larvæ of a butterfly (*Papilio polyxenes*). The following sources of odors were employed and the average reaction time of the above larvæ to them are: Oil of peppermint, 14.6 seconds; oil of thyme, 9.5 seconds; oil of wintergreen, 17.6 seconds; dried leaves of pennyroyal, 20.1 seconds; dried leaves of spearmint, 22.9 seconds; wild cherry-tree leaves, 42.5 seconds; fresh grass, 19.1 seconds, old honey and comb, 51.5 seconds; protruded thoracic glands of above Papilio larvæ, 22.8 seconds; and as a control—a clean and empty vial, 60 seconds (totally negative). The details pertaining to these experiments are as follows:

In each set of experiments 10 larvæ were used, one larva being confined in a case. As a rule, the more the larvæ were handled the more satisfactorily they responded to odors, but generally speaking these larvæ were the most unfavorable insects that the writer has ever used for testing the responses to odors. When placed in the experimental cases, all of them,

except the army worms, had the habit of crawling into the corners and lying there more or less dormant and in such a position would never respond to odors; therefore, before testing a larva it was first necessary to see that it was lying flat on the bottom of the case, and in order to insure, if possible, a response to another odor after an interval of 15 minutes, it was usually touched with a pencil to "awaken it from its stupor." Caterpillars in their webs rarely responded to the odors used. The following records include only the first responses and their reaction times.

MEDIUM SIZED TENT CATERPILLARS (*Malacosoma americana* Fab.).

Oil of peppermint:
6 moved head slightly. 1 raised head and crawled away.
1 moved away slowly. 1 moved head and worked mouth parts.
1 raised head quickly.
Reaction time 3 to 15 seconds, average 7.5 seconds.

Oil of thyme:
6 moved head slightly. 1 raised head and moved away slowly.
3 moved away slowly.
Reaction time 3 to 15 seconds, average 5.4 seconds.

Oil of wintergreen:
5 moved head slightly. 2 raised head and moved away slowly.
2 showed no response. 1 moved away slowly.
Reaction time 4 to 60 seconds, average 20.6 seconds. In all cases 60 seconds was regarded totally negative.

Dried leaves of pennyroyal:
5 moved away slowly. 1 moved head sidewise.
3 moved head slightly. 1 showed no response.
Reaction time 3 to 60 seconds, average 22.2 seconds.

Dried leaves of spearmint (odor very weak):
5 showed no response. 2 moved head slightly.
2 moved away slowly. 1 moved leg back and forth.
Reaction time 5 to 60 seconds, average 38.3 seconds.

Wild cherry tree leaves cut into small pieces (their favorite food):
4 showed no response. 1 moved away slowly.
4 moved head slightly. 1 raised head slowly.
Reaction time 5 to 60 seconds, average 42.5 seconds.

Old honey and comb (odor very faint):
6 showed no response. 4 moved head slightly.
Reaction time 20 to 60 seconds, average 51.5 seconds.

Empty and odorless vial (used as a control):
10 showed no response.

SMALL FALL WEBWORMS (*Hyphantria cunea* Dru.)

Oil of peppermint:
3 moved slightly. 1 moved head sidewise.
2 raised head and thorax quickly. 1 turned around.
2 worked mouth parts. 1 raised head.
Reaction time 2 to 40 seconds, average 11.8 seconds.

Oil of thyme:
4 raised head quickly. 1 moved away quickly.
3 moved head and worked mouth parts. 1 raised thorax quickly.
1 moved slightly.
Reaction time 2 to 10 seconds, average 4.5 seconds.

Oil of wintergreen:
3 moved head slightly. 1 worked mouth parts.
2 raised head quickly. 1 moved head sidewise.
2 moved away quickly. 1 raised head and thorax slowly.
Reaction time 2 to 30 seconds, average 7.5 seconds.

Dried leaves of pennyroyal:
5 moved slightly. 1 moved head slightly.
2 raised head and thorax slowly. 1 moved head and thorax sidewise and bit wire-screen bottom of case.
1 moved away slowly.
Reaction time 2 to 25 seconds, average 7.4 seconds.

Dried leaves of spearmint (odor very weak):
4 moved slightly. 2 moved away quickly.
2 raised head quickly. 1 moved head slightly.
1 moved slightly.
Reaction time 3 to 15 seconds, average 6.4 seconds.

LARGE TUSSOCK-MOTH LARVAE (*Hemerocampa leucostigma* S. and A.)

Oil of peppermint:
6 moved slightly. 1 showed no response.
2 moved away. 1 raised head and thorax quickly.
Reaction time 2 to 60 seconds, average 17.3 seconds.

Oil of thyme:
8 moved slightly. 1 showed no response.
1 raised head.
Reaction time 2 to 60 seconds, average 13.1 seconds.

Oil of wintergreen:
3 raised head. 1 moved head sidewise.
2 moved slightly. 1 moved away slowly.
2 jerked head backward. 1 showed no response.
Reaction time 2 to 60 seconds, average 16.3 seconds.

Dried leaves of pennyroyal:
4 moved away slowly. 2 raised head.
3 moved slightly. 1 showed no response.
Reaction time 2 to 60 seconds, average 23.2 seconds.

Dried leaves of spearmint (odor very weak):
6 moved away. 2 showed no response.
2 moved slightly.
Reaction time 5 to 60 seconds, average 30 seconds.

Protruded thoracic glands of larvæ (*Papilio polyxenes*).
5 moved slightly. 2 showed no response.
2 moved away slowly. 1 raised head.
Reaction time 2 to 60 seconds, average 22.8 seconds.

LARGE ARMY WORMS (*Cirphis unipuncta* Haw.)

Oil of peppermint:
5 raised head quickly. 3 raised head quickly and waved it sidewise.
2 raised head slowly.
Reaction time 2 to 5 seconds, average 2.9 seconds.

Oil of thyme:
4 raised head quickly and moved sidewise. 3 raised head quickly.
3 raised head slowly.
Reaction time 2 to 5 seconds, average 2.5 seconds.

Oil of wintergreen:
5 raised head quickly and moved it sidewise.
2 raised head quickly and moved backward.
2 raised head slowly.
1 raised head quickly.
Reaction time 2 to 10 seconds, average 2.9 seconds.

Dried leaves of pennyroyal:
8 raised head slowly.
1 raised head quickly.
1 moved away slowly.
Reaction time 2 to 10 seconds, average 4.2 seconds.

Dried leaves of spearmint (odor very weak):
6 raised head slowly.
3 raised head quickly.
1 raised head slowly and waved it sidewise.
Reaction time 2 to 4 seconds, average 2.7 seconds.

Fresh grass in vial (food of these larvæ):
2 raised head slowly.
2 moved slightly.
2 showed no response.
2 moved backward slowly.
1 moved forward quickly.
1 raised head and bit screen-wire bottom of case.
Reaction time 2 to 60 seconds, average 19.1 seconds.

BUTTERFLY LARVAE (*Papilio polyxenes* Fab.)

Oil of peppermint:
5 raised head.
5 showed no response.
Reaction time 3 to 60 seconds, average 33.2 seconds.

Oil of thyme:
5 raised head.
2 moved quickly.
2 showed no response.
1 moved caudal end of body.
Reaction time 2 to 60 seconds, average 22.1 seconds.

Oil of wintergreen:
5 moved slightly.
5 showed no response.
Reaction time 7 to 60 seconds, average 40.7 seconds.

Dried leaves of pennyroyal:
4 showed no response.
3 raised head.
3 moved slightly.
Reaction time 10 to 60 seconds, average 43.5 seconds.

Dried leaves of spearmint (odor very weak):
5 showed no response.
3 raised head.
2 moved slightly.
Reaction time 3 to 60 seconds, average 37.3 seconds.

In comparing the preceding reaction times, no conclusion can be drawn in regard to the comparative sensitiveness of the five species tested, because the responses depended more on the behavior of the larva tested than on its ability to perceive chemical stimuli. Of the five species used, only the army worms were favorable for experimental purposes; these were usually active, never failed to respond when tested, and the responses were generally quick and pronounced ones. Of the five species used, the butterfly larvæ were the most sluggish and their reaction times are the slowest of all.

MORPHOLOGY OF OLFACTORY PORES OR PUNCTURES.

The preceding pages show that lepidopterous larvæ respond to chemical stimuli, and the following pages will show that these larvæ have organs suitable for the reception of chemical stimuli, but no experiments were performed to determine the function of these organs which were first called olfactory pores by the writer (1914a). The same type of organs seems to be common to all adult insects and the writer has proved experimentally that they receive chemical stimuli in Hymenoptera (1914b) and Coleoptera (1915). They have also proved to be common to all of the coleopterous and lepidopterous larvæ yet examined by the writer, and now for several years systematists have known them in lepidopterous larvæ as "punctures." The writer (1918) has recently described the external and internal anatomy of them in a coleopterous larva of the 'fig-eater,' *Allorhina* (*Cotinis*) *nitida* L.

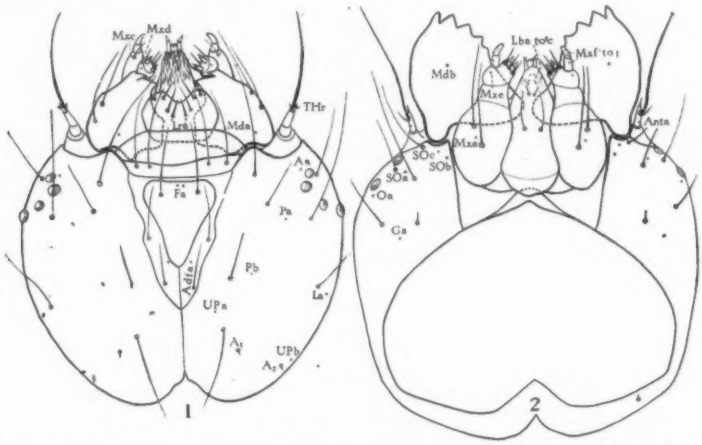
1. Disposition of Pores or Punctures.

In making a comparative study of the distribution and number of these pores in lepidopterous larvæ, 30 species, belonging to 28 genera and representing 20 families have been used. Most of these were collected by the writer and the remainder were kindly furnished by Mr. Carl Heinrich who identified all of them. With a few exceptions, the writer has adopted Mr. Heinrich's (1916, 1918) nomenclature given to most of the punctures present on the head capsule and at the suggestions of Messrs. Heinrich and Busck he has formulated new names for those pores not already named. The various parts of the anatomy on which these pores occur were verified by Dr. Adam Böving; the three foregoing mentioned men also belong to the Bureau of Entomology.

In most cases only one specimen of each species was examined, and consequently, owing to unfavorable mounts and the lack of sufficient material, the total number of pores recorded can not be regarded as accurate. Since the army worm was the most favorable material at hand, several specimens of it were treated with caustic potash and the pores on it have been studied and drawn in detail.

The description of them will be given first and then will follow a brief account of those in other species.

Army Worm: Upon examining the head capsules of lepidopterous larvæ under a low-power lens, several minute circular light spots were seen; these spots resemble hair sockets from which the hairs have been removed, but former studies dealing with similar spots at once suggested that they might be the olfactory pores, so common to adult insects and coleopterous larvæ. Upon examining them under a high-power lens, it was soon observed that their external anatomy is different from that of hair sockets and sections through them proved that they are really olfactory pores.



FIGS. 1 AND 2.—Disposition of the pores or punctures and setæ on the head of a small army worm (*Cirphis unipuncta* Haw.), only the pores being here named, × 20. Fig. 1, dorsal view and Fig. 2, ventral view. Frontal pore (*Fa*); adfrontal pore (*Adfa*); anterior pore (*Aa*); posterior pores *a* (*Pa*) and *b* (*Pb*); lateral pore (*La*); ultraposterior pores *a* (*UPa*) and *b* (*UPb*); labral pore (*Lra*); mandibular pores *a* (*Mda*) and *b* (*Mdb*); maxillary pores *a* (*Mxa*), *c* (*Mxc*), *d* (*Mxd*), *e* (*Mxe*), and *f* to *j* (*Mxf* to *j*); labial pores *a* to *c* (*Lba* to *c*); antennal pore (*Anta*); genal pore (*Ga*); ocellar pore (*Oa*); subocellar pores *a* (*SOa*), *b* (*SOb*) and *c* (*SOc*); secondary setæ (A_1 and A_2); and Nagel's so-called olfactory pegs on antennæ (*THr*).

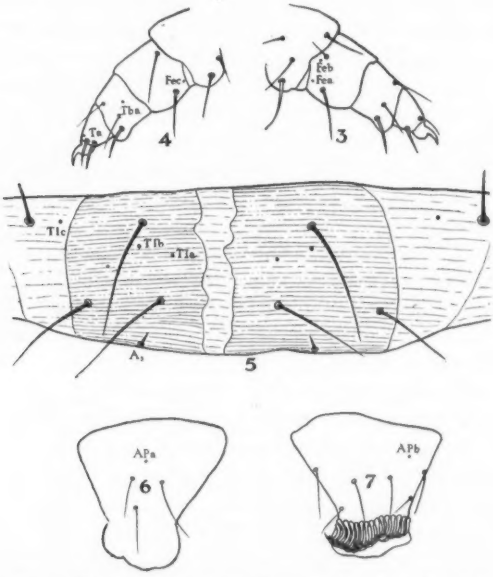
Referring to Figures 1 and 2, it is seen that they are always paired and they are located and named as follows: On the front: the frontal pore (*Fa*); on the adfrontal piece: the adfrontal pore (*Adfa*); on the dorsal sureface of the epicranium: the anterior pore (*Aa*), posterior pores *a* (*Pa*) and *b* (*Pb*), lateral pore (*La*), and ultraposterior pores *a* (*UPa*) and *b* (*UPb*); on the ventral surface of the epicranium: the genal pore (*Ga*),

ocellar pore (*Oa*), and subcellar pores *a* (*SOa*), *b* (*SOb*) and *c* (*SOc*); on the dorsal and ventral surfaces, respectively, of the mandible: the mandibular pores *a* (*Mda*) and *b* (*Mdb*); on the ventral surface of the labium: the labial pores *a*, *b* and *c* (*Lba* to *c*); and on the dorsal surface of the labrum: the labral pore (*Lra*). Relative to the maxilla they are as follows: On the ventral surface of the stipes: the maxillary pore *a* (*Mxa*); on the dorsal surfaces of the palpiger, first segment of the maxillary palpus and maxillary lobe, respectively: the maxillary pores *b*, *c* and *d* (Fig. 8, *Mxb* to *d*); on the ventral surfaces of the first, second and third segments of the maxillary palpus, respectively: the maxillary pores *e* (Fig. 2, *Mxe*) and *f* to *j* (*Mxf* to *j*). On the ventral surface of the second or terminal segment of the antenna, near the proximal end at the outer side, lies the antennal pore (*Anta*).

Relative to the thorax and abdomen, the pores are located and may be named as follows: On the anterior surface of the femur: the femoral pores *a* and *b* (Fig. 3, *Fea* and *Feb*); on the posterior surface of the femur: the femoral pore *c* (Fig. 4, *Fec*); on the posterior surfaces of the tibia and tarsus, respectively: the tibial pore (Fig. 4, *Tba* and tarsal pore (*Ta*); on the tergum of the prothorax: the thoracic pores *a*, *b* and c (Fig. 5, *TIa* to *c*); on the tergum of the last abdominal segment: a single pair of pores, the abdominal pores (not drawn); and on the dorsal and ventral surfaces, respectively, of the anal proleg: the anal-proleg pores *a* and *b* (Figs. 6 and 7, *APa* and *APb*).

Relative to the pores on the head of the army worm, the subocellar pores (Fig. 2, *SOb* and *SOc*) and mandibular ones (*Mdb*) are the most difficult to be found. While the former lie in almost transparent chitin, the latter one lies in very dark chitin; all of these, as well as the pair (Fig. 1, *Mda*) on the dorsal side of the mandibles, seem to have been overlooked by other observers. The ultraposterior ones (Fig. 1, *UPa* and *UPb*) are easily mistaken for the secondary setæ (A_1 and A_2) and can only be distinguished from them by aid of a high-power lens. Perhaps all of the pores on the labium and maxillæ have been seen by systematists, but it seems that the third labial pair (Figs. 2 and 20, *Lbc*), and maxillary pores *b*, *g* to *j* (Figs. 8 and 9, *Mxb*, *g* to *j*) have never been drawn. As far as known to the writer, those on the legs, last abdominal segment and on the anal prolegs are here reported for the first time.

The location and total number of the pores on various parts of the army worm are as follows: front, 2; adfrontal piece, 2; epicranium, 22; antennæ, 2; mandibles, 4; labium, 6; labrum, 2; maxillæ, 20; trochanters, 18; tibiæ, 6; tarsi, 6; prothorax, 6; last abdominal segment, 2; and anal prolegs, 4; making 102 pores in all.



FIGS. 3 TO 7.—Disposition of pores or punctures on leg, first thoracic segment and on anal proleg of a small army worm, × 20. Figs. 3 and 4, anterior and posterior surfaces, respectively, of left prothoracic leg. Fig. 5, most of tergum of prothorax; the shield or strongly pigmented stripes are more heavily shaded than are the lightly pigmented portions. Figs. 6 and 7, dorsal and ventral surfaces, respectively, of same anal proleg. Femoral pores *a* (*Fea*), *b* (*Feb*) and *c* (*Fec*); tibial pore (*Tba*); tarsal pore (*Ta*); thoracic pores *a* (*Tla*), *b* (*Tlb*) and *c* *Tlc*); anal-proleg pores *a* (*APa*) and *b* (*APb*); and secondary seta (A_3).

Other species. The integuments of other species examined were not studied as critically as were those of the army worm, and consequently, some of the pores have certainly been overlooked, particularly the ones most difficult to be found. Some of the preparations had to be bleached with chlorine gas before they could be studied, but most of them were so light in color that it was difficult to find some of the pores, and the butterfly

larvæ were the least favorable of all, owing to their almost total lack of pigment and to the fact that the hairs on the epicranium arise from large tubercles.

The following table gives the larger variations concerning the disposition of these pores and now the smaller variations may be briefly stated. For sake of brevity, instead of using the long scientific names of the larvæ examined, the species will be numbered from 1 to 30, and those interested in associating the names of the species with the variations described may do so by referring to the names and numbers of the species in the table on page 76. For each of the 30 species examined, the pores are constant in number on the following parts of the integument: Front, 2; each antenna, 1; each stipes, 1; each maxillary lobe, 1; each second segment of the maxillary palpus, 1; and each third or terminal segment of the maxillary palpus, 4. The number of pores found on the epicranium (including the adfrontal piece) varies as follows: On each of 14 species, 10 pores (Nos. 1, 3, 6, 10, 12, 14, 16–18, 21, 24, 25, 29, 30); on each of 4 species, 12 pores (Nos. 2, 4, 5, 22); on each of 9 species, 14 pores (Nos. 9, 11, 13, 15, 19, 20, 23, 27, 28); on each of 2 species, 18 pores (Nos. 7, 26); and on 1 species, 24 pores (No. 8, the army worm).

If all of the pores on each epicranium had been found, perhaps 20 would be a common number for nearly all of the species. One pore was found on each mandible of 29 species, but had this appendage been examined more carefully two pores might have been found on each mandible as already shown for the army worm. The number of pores found on the labium varies as follows: On each of 12 species, 4 pores (Nos. 1, 12, 13, 15–21, 23, 26); and on each of 18 species, 6 pores (Nos. 2–11, 14, 22, 24, 25, 27–30). The number of pores found on the labrum varies as follows: On each of 5 species, 2 pores (Nos. 7–10, 16); on each of 11 species, 4 pores (Nos. 6, 11, 14, 17–19, 21, 23, 25–27); and on each of 14 species, 6 pores (Nos. 1–5, 12, 13, 15, 20, 22, 24, 28–30). The first segment of each maxillary palpus has 1 pore, except 2 were found on each one of 4 species (Nos. 3–5, 8). Three pores were found on each femur, except 2 on each one of 10 species (Nos. 14, 15, 17–19, 21, 22, 24, 25, 29). One pore was found on each tibia, except 2 pores on each of 1 tibia of 2 species (Nos. 9, 14) and 3 pores on 1 tibia of 1 species (No. 30). One pore was found on each tarsus, except

TABLE I.

Disposition of the pores or punctured found on *lepidopterous larvæ*.

Family and Number and Name of Species	Number of Pores on					Total No. of pores found
	Head		Thorax		Abdomen	
	Head capsule	Head appendages	Legs	First thoracic segment	Last segment and anal prolegs	
SPHINGIDÆ—						
1. *Phlegothontius sexta* Joh.	12	30	30	...	...	72
2. *Ceratomia catalpæ* Bvd.	14	32	30	...	...	76
SATURNIIDÆ—						
3. *Antomeris io* Fab.	12	36	30	...	...	78
ARCTIIDÆ—						
4. *Hyphantria cunea* Dru.	14	34	30	...	...	78
NOCTUIDÆ—						
5. *Apatela(Acronycta)americana*Harr	14	34	30	...	1	79
6. *Prodenia ornithogalli* Guen.	12	30	30	...	...	72
7. *Feltia* sp.	20	28	30	6	2	86
8. *Cirphis unipuncta* Haw.	26	34	30	6	6	102
NOTODONTIDÆ—						
9. *Datana integerrima* G. & R.	16	28	31	3	...	78
10. *Datana ministra* Dru.	12	28	30	2	...	72
LIPARIDÆ—						
11. *Hemerocampa leucostigma* S.& A.	16	30	30	...	...	76
LASICAMPIDÆ—						
12. *Malacosoma americana* Fab.	12	30	30	2	2	76
BOMBYCIDÆ—						
13. *Bombyx mori* L.	16	30	30	...	3	79
GEOMETRIDÆ—						
14. *Alsophila pometaria* Harr.	12	30	19	...	...	61
PSYCHIDÆ—						
15. *Thyridopteryx ephemeræformis* Haw.	16	30	18	...	...	64
COCHLIDIIDÆ—						
16. *Sibine stimulea* Clem.	12	26	30	...	...	68
MEGALOPYGIDÆ—						
17. *Lagoa crispata* Pack.	12	28	24	...	...	64
18. *Megalopyge opercularis* S. & A.	12	28	24	...	...	64
ZYGÆNIDÆ—						
19. *Harrisina americana* Guér-Mén.	16	28	24	...	...	68
PYRALIDÆ—						
20. *Diatræa saccharalis* Fab.	16	30	30	4	...	80
21. *Achroia grisella* Fab.	12	28	24	...	...	64
22. *Dioryctria abeitella* D. & S.	14	32	24	4	1	75
OLETHREUTIDÆ—						
23. *Laspeyresia pomonella* L.	16	28	30	3	1	78
24. *Laspeyresia molesta* Busck.	12	32	24	2	...	70
YPONOMEUTIDÆ—						
25. *Atteva aurea* Fitch.	12	30	24	...	...	66
GELECHIIDÆ—						
26. *Pectinophora gossypiella* Saund.	20	28	30	2	...	80
BLASTOBASIDÆ—						
27. *Valentinia glandulella* Riley.	16	30	30	2	...	78
PAPILIONIDÆ—						
28. *Papilio polyxenes* L.	16	32	30	...	...	78
PIERIDÆ—						
29. *Pontia rapæ* L.	12	32	24	...	...	68
NYMPHALIDÆ—						
30. *Basilarchia archippus* Cram.	12	32	32	...	...	76
Variation.	12-26	26-36	18-32	0-6	0-6	61-102

none on the tarsi of 2 species (Nos. 14, 15). The number of pores found on the first thoracic segment varies as follows: Six on each of 2 species (Nos. 7, 8); 4 on each of 2 species (Nos. 20, 22); 3 on each of 2 species (Nos. 9, 23); and 2 on each of 5 species (Nos. 10, 12, 24, 26, 27). Two pores were found on each of the last abdominal segment of 3 species (Nos. 7, 8, 13). The number of pores on both anal prolegs varies as follows: One for each of 3 species (Nos. 5, 22, 23); 2 for each of 2 species (Nos. 12, 13); and 4 for the army worm (No. 8).

The total number of pores found varies from 61 to 102, but no conclusion in regard to the comparative sensitiveness of the various species can be drawn, owing to the fact that only one of the species listed was critically studied.

In these examinations no attention has been paid to the size or age of the larva being examined and at first thought one might think that the disposition of the pores would vary according to the instars, but Mr. Busck informs me that he has found no such variations.

Discussion. According to the earlier papers concerning lepidopterous larvæ, some of the entomologists have observed the more conspicuous pores on the heads of these larvæ; they have called these organs sensory pits and punctures, but knew nothing about their internal anatomy. Within the past few years, systematists have been making comparative studies of the setæ and punctures present on the integuments of lepidopterous larvæ and have used these characters successfully for classifying the larvæ.

Forbes (1910) seems to have presented the first comparative paper on this subject. He appears to have found some punctures on all of the larvæ examined; he has mapped the frontal punctures on 33 species and adfrontal ones on 28 species, but represents only a few of those present on the epicranium and mouth parts. The same author (1911) mapped 3 pairs of punctures on the labrum each of 4 sphingids.

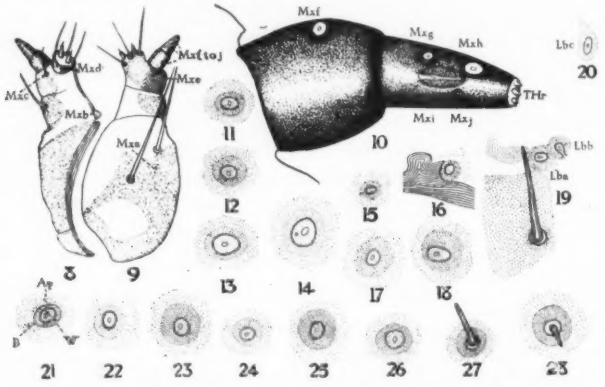
Tsou (1914) mapped 2 pairs of punctures on the dorsal surface of the prothorax of two genera.

Fracker (1915) mapped the frontal and adfrontal punctures of several species.

Heinrich (1916) named and mapped most of the punctures present on the head capsule of a micro-lepidopteron, and the

same author (1918) continued this study using the genus *Opostega*.

Busck (1917) mapped most of the punctures present on the head capsules of the pink bollworm (*Pectinophora gossypiella* Saund.) and the scavenger bollworm (*Pyroderces rileyi* Wals.). He found 22 punctures on each capsule, while the present writer found 20 on the former capsule; in all probability there are 26 on each capsule.



FIGS. 8 TO 28.—Disposition and external view of pores or punctures on same army worm as represented in Figs. 1 to 7. Figs. 8 and 9, disposition of pores on dorsal and ventral surfaces, respectively, of left maxilla, × 50. Maxillary pores *a* to *j* (*Mxa* to *j*). Figs. 10 to 28, external structures of pores and setæ, × 320. Fig. 10, ventral surface of second and third segments of maxillary palpus, showing maxillary pores *f* to *j* (*Mxf* to *j*) and tactile hairs (*THr*) at tip of palpus. Fig. 11, tibial pore; Fig. 12, thoracic pore *c;* Fig. 13, abdominal pore; Fig. 14, anal-proleg pore *b;* Figs. 15 and 16, maxillary pores *d* and *b*, respectively; Fig. 17, labral pore; Fig. 18, mandibular pore *a;* Figs. 19 and 20, labial pores *a* to *c*, drawn in proper relation to each other; Fig. 21, frontal pore; Fig. 22, adfrontal pore; Fig. 23, lateral pore; Fig. 24, subocellar pore *c;* Fig. 25, ultraposterior pore *b;* Fig. 26, antennal pore; Fig. 27, secondary seta (Fig. 5, A_3) on prothorax; and Fig. 28, secondary seta (Fig. 1, A_2) on head. Pore aperture (*Ap*); pore border (*B*); and pore wall (*W*).

2. External Anatomy of Pores or Punctures.

Under a high-power lens it is observed that a pore usually has a dark border (Fig. 21, *B*) which may be round, oblong or occasionally almost diamond-shaped, and it may show indications of radial streaks. Inside the border lies the wall (*W*) which is usually dark and heavy; it is the most conspicuous part of the organ and may be round or oblong. Inside the wall the chitin is lighter in color and at the center may be seen an

aperture (*Ap*) which appears as a transparent spot; the aperture is a minute opening passing through the thin chitin inside the wall.

Sometimes it is almost impossible to distinguish a secondary seta from a pore, but in almost all cases the chitin inside the wall of such a seta is lighter in color than that inside the wall of a pore, and this fact may help to distinguish a seta from a pore in case the seta has been pulled out; this comparison may be seen by referring to Figures 25 and 28, both of which structures come from the same region on the epicranium.

In size the pores do not vary greatly, as may be observed by looking at Figures 10 to 28. The smallest one (Fig. 10, *Mxj*) lies on the terminal segment of the maxillary palpus and the largest one (Fig. 14) in the army worm lies on the anal proleg; the former is scarcely discernible and seldom has a border. The one (Fig. 10, *Mxi*) nearest it is always slit-shaped and also in some species can scarcely be seen. The other two (*Mxg* and *Mxh*) on this segment are easily seen in good mounts, and have distinct borders.

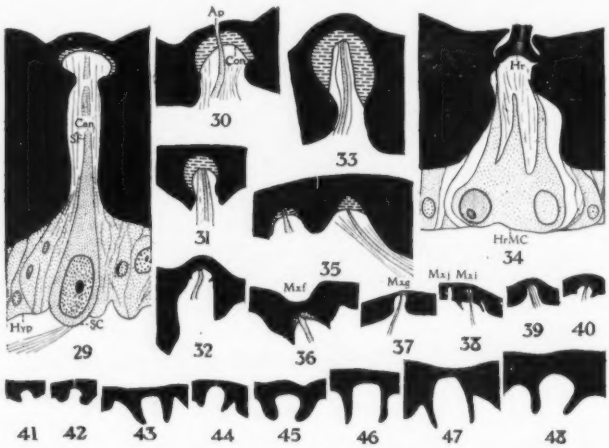
3. Internal Anatomy of Pores or Punctures.

A reference to Figures 29 to 48 shows that the internal structure of these organs is like that of those in other insects, and consequently only a brief description of the various parts of them will suffice here. Lying in the thick hypodermis (Fig. 29, *Hyp*) is the large sense cell (*SC*) whose peripheral end (*SF*) passes through the pore canal (*Can*), pierces the chitinous cone (Fig. 30, *Con*) and then stops in the bottom of the pore aperture (*Ap*) where it seems to come in direct contact with the external air. The chitin covering the cone may be dome-shaped, with the dome either lying in a depression (Fig. 29) or elevated above the surrounding chitin(Fig. 33); or it may form a depression whose bottom is pierced by the pore aperture (Fig. 36); or it may lie on the same level with the surrounding chitin (Fig. 31).

Since the chitin was so thick, not a single section showed all the details of one of these organs, because the microtome knife never passed properly through the structure; but Figures 29 and 30 combined give a good idea of their anatomy, which is very different from the internal anatomy of a large hair (Fig. 34) which is formed by a large hair-mother cell (*HrMC*) sending

forth processes through the pore canal to the base of the hair (*Hr*). Should both the base of the hair and the hair-mother cell be missing, the hair socket itself in sections serves well to distinguish this structure from a pore.

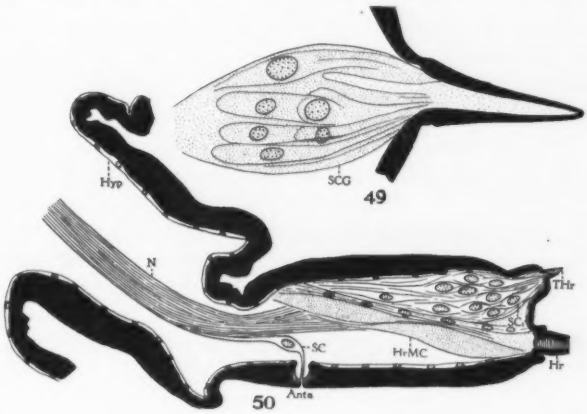
To determine whether all of the structures recorded as pores are really pores or hair sockets, thin sections made through the various parts of the integuments bearing these structures were



FIGS. 29 TO 48.—Sections, showing internal anatomy of pores or punctures and of one hair from various lepidopterous larvæ, × 500. Figs. 29, 31 to 34 are pores from *Ceratomia catalpæ*; Fig. 29, being from epicranium; Fig. 31, from antenna; Fig. 32, from palpiger; Fig. 33, from labium; and Fig. 34 is internal structure of a large hair on epicranium. Fig. 30 is a pore from labrum of *Telea polyphemus* and Fig. 35, two pores from labrum of silkworm (*Bombyx mori*). Figs. 36 to 38, maxillary pores *f* (*Mxf*), *g* (*Mxg*), *j* (*Mxj*) and *i* (*Mxi*), respectively, of tomato worm *Phlegothontius sexta*). Fig. 39, pore from labrum and Fig. 40, pore from antenna of cabbage-butterfly larva (*Pontia rapæ*). Figs. 41 to 48, sections from material, treated with caustic potash. Fig. 41, pore from terminal segment of maxillary palpus of codling moth (*Laspeyresia pomonella*). Figs. 42 to 48, pores from army worm (*Cirphis unipuncta*); Fig. 42, from tibia; Fig. 43, from antenna; Fig. 44, from maxillary lobe; Fig. 45, from femur; Fig. 46, from mandible; Fig. 47, from front; and Fig. 48, from anal proleg. Sense cell (*SC*); hypodermis (*Hyp*); sensory fiber (*SF*); pore canal (*Can*); chitinous cone (*Con*); pore aperture (*Ap*); hair-mother cell (*HrMC*); and base of hair (*Hr*).

carefully studied; in every case the suspected pore proved to be a real pore. Since most of these are so scattered, they are easily overlooked in sections made from fixed material, but were found much more easily in sections made from material treated with caustic potash (Figs. 41 to 48).

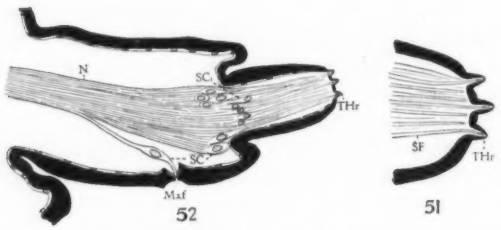
Nagel (1894) called the small hairs at the tip of the antennæ (Fig. 1, *THr*) of a lepidopterous larva olfactory pegs, but in the opinion of the present writer they are nothing more than tactile hairs. Sections through them show that they are not true hairs, because they do not arise from sockets, but each one is nevertheless innervated; the larger ones seem to be provided with sense cell groups (Fig. 49, *SCG*), while the smaller ones (Fig. 50, *THr*) arising from the dome seem to be provided with



FIGS. 49 AND 50.—Longitudinal sections, showing internal anatomy of antenna of tomato worm. Fig. 49, the larger type of one of Nagel's so-called olfactory pegs at tip of antenna, × 500; sense-cell group (*SCG*). Fig. 50 shows how well antenna is innervated; semidiagrammatic, × 100. Hypodermis (*Hyp*); nerve (*N*); antennal pore (*Anta*); probably hair-mother cell (*HrMC*); sense cell (*SC*), connected with pore; sense cell (SC_1), connected with peg; smaller type of one of Nagel's so-called olfactory pegs (*THr*) arising from dome; and base of large true hair (*Hr*).

single sense cells (SC_1). The large hair (*Hr*) at the tip of the antenna is a true hair, but it does not appear to be sensory, although lying at its base there are one or two large cells (*HrMC*) which resemble hair-mother cells more than sense cells.

One author draws the antennæ of lepidopterous larvæ as if they were composed of 3 or 4 segments, but sections show only two distinct segments in each, although sometimes the basal one is so folded that indications of two more segments are visible, as shown in Figure 50, which also gives a good idea of how well the antenna is innervated.



FIGS. 51 AND 52.—Longitudinal sections, showing internal anatomy of maxillary palpus. Fig. 51 shows sensory fibers (*SF*) running to 3 of hairs (*THr*) at tip of palpus of *Ceratomia catalpæ*, × 500. Fig. 52 shows how well palpus is innervated; semidiagrammatic, × 190. Sense cells (SC_1), connected with hairs (*THr*); sense cells (*SC*), connected with pores; maxillary pore *f* (*Mxf*); and nerve (*N*).

The terminal segment of the maxillary palpus ends bluntly (Fig. 53) and the tip is provided with 8 or 9 minute pseudohairs (Figs. 51 and 52, *THr*), each of which seems to be innervated by a single sense cell (SC_1). These sense cells lie in a group at the proximal end of the segment near another group of sense cells (*SC*) which evidently belong to the pores. Figures 52 and 53 show how well the maxillary palpus is innervated; a portion of the terminal segment in Figure 53 is shown in perspective.

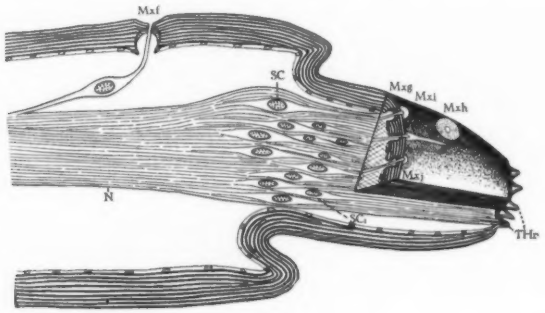


FIG. 53.—Schematic drawing of maxillary palpus of tomato worm, showing innervation of maxillary pores *f* to *j* (*Mxf* to *j*) and tactile hairs (*THr*); a portion of terminal segment is in perspective.

SUMMARY.

To determine whether lepidopterous larvæ respond to chemical stimuli, tent caterpillars, fall webworms, tussock-moth larvæ, army worms and larvæ of *Papilio polyxenes* were tested by using the following sources of odors: Oils of peppermint, thyme and wintergreen, dried leaves of pennyroyal and spearmint, wild cherry-tree leaves, fresh grass, old honey and comb, and the protruded thoracic glands of the above Papilio larvæ. The larvæ usually responded to the exhalations from these substances, but the average reaction times obtained seemed to depend more on the degree of sluggishness of the larvæ than on their sensitiveness to odors.

Organs, called olfactory pores by the writer, but known as punctures to systematists, were found widely distributed on the head capsule, head appendages, legs, dorsal surfaces of the prothorax and last abdominal segment, and on the anal prolegs. It is believed that a few of those on the head and all of those found on the legs and abdomen are here reported for the first time. Their internal structure is like that of those in adult insects and coleopterous larvæ, and consequently are well adapted to receive chemical stimuli, because their sensory fibers running from the sense cells pass into the minute pores or punctures and seem to come in direct contact with the external air. No experiments, however, were performed to determine their function.

Verschaffelt determined experimentally that cabbage-butterfly larvæ are attracted by the various mustard oils contained in the host plants, and this explains why these larvæ refuse plants not containing such oils; he also thinks that the larvæ smell the odors from the mustard oils before they begin to eat the food. If we knew more about the chemotaxis of insects, we might be able to devise practical methods for the control of certain insects, as by trap baits, etc.

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THE STREPTOCERA GROUP OF THE DIPTEROUS GENUS TIPULA LINNAEUS.

W. G. Dietz, M. D.

A natural group of species, which briefly may be characterized as follows: Wings approximately unicolorous, stigma distinct, the antestigmal spot always extends into cell 1st M2, but is interrupted in the outer end of cell R in most of the species. The eighth sternite of the male is prolonged and narrowed posteriorly, except devia. The hypopygium is of moderate size. The ninth tergite, generally small, is emarginate in the middle, except fragmentata. The pleural suture is distinct, except devia—the pleurite prolonged into a process, generally long and twisted, hornlike, rarely into an acutely pointed cone, derbyi, or simply tipped by a sharp point, devia. The ovipositor is very short, the upper valves generally rounded or oval, in some species ending in a downward curved point, giving thus a beaklike appearance; the lower valves scaphoidal. In all the specimens in my collection, the posterior end of the abdomen, especially the males, is curved upward and sometimes backwards towards the abdominal tergum. Whether this also obtains in the living insect I have no means to know.

The species, below medium in size, are yellowish to testaceous in color, with more or less lustre. They resemble each other very closely and the genital structure of the males must in almost all cases be depended upon for differentiation.

KEY TO THE SPECIES.

1. Joints of the antennal flagellum unicolorous. Western species.....2
   Flagellar joints bicolored. Eastern United States; aberrant form. .....*devia* spec. n.
2. The ninth tergite of the male distinctly emarginate.....3
   Not as in the alternative.....*fragmentata* spec. n.
3. The pleural process long, hornlike.....4
   The pleurite prolonged into a pointed, conelike process....*derbyi* Doane
4. The pleural process long, twisted, more or less curved, glabrous.....5
   The process shorter, approximately straight, stiletto-like, hairy, ...*monochroma* Spencer
5. Process conspicuously curved.....6
   Process approximately straight.....*trypetophora* spec. n.
6. The ninth tergite with a deep, oval emargination, the sides prolonged into converging processes, the inner margin with a conspicuous tooth. .....*opisthocera* spec. n
   Not as above.....7
7. Process shorter, viewed laterally, much wider in basal half...*mutica* spec. n.
   Not as in the alternative.....8
8. Antennal flagellum—except basal joint—dark brown.....*streptocera* Doane
   Antennæ entirely yellowish.....var. *streptocera pallidocera* var. n.

Tipula devia sp. nov.

Yellow. Antennæ yellow, flagellar joints beyond the third, brown at the base. Thoracic stripes obsolete. Pleurite of hypopygium tipped with a sharp point.

Male, length 13 millimeters, wing 14.5 millimeters.

Head entirely, together with mouth-parts and palpi, yellow; last joint of palpi a trifle longer than the three preceding joints together. Antennæ yellow, flagellar joints beyond the third brownish at the base; joints cylindrical, basal enlargement very slight, the setæ about as long as the respective joints. Thorax concolorous, dorsum subtranslucent, stripes obsolete, pleura with a faint whitish sheen, coxæ and trochanters yellow, rest of legs lost. Halteres pale yellow, club infuscate. Wings light gray, costal cells yellow, stigma light fuscous, veins C, S C, R and Cu, yellow, the other veins brown; the antestigmal spot strongly marked, extending through cell 1st M2 into base of cell M3. As far as I can perceive, vein M1 and M2 alone are distinctly setigerous, the setæ rather long.

Abdomen yellow, darker posteriorly, the eighth sternite very little prolonged, the posterior margin with a median notch and a slight emargination on each side; a dense brush of golden-yellow, bristly hair arises from beneath the margin and a stout bristle, curved outward from the lateral angle. Hypopygium (Pl. V, Figs. 1 and 2) testaceous. Ninth tergite markedly narrowed posteriorly, deeply emarginate, the upper surface impressed mesially, the sides of the tergite prolonged into an acute process, denticulate within. Ninth sternite broadly emarginate, base of the emargination subangulate. Pleural suture obsolete, the pleurite projects as an acute point. Outer apical appendages large, hatchet-shaped, projecting inward, lower appendages large, sausage-shaped bodies, coarsely hairy and projecting downward into the emargination of the ninth sternite.

Holotype, ♂. Plummers Island, Maryland, June 28th, 1914 (W. F. McAtee).

A distinct, but somewhat aberrant species in this group. The absence of the pleural suture, the pleurite merely projecting into an acute point and the scarcely prolonged eighth sternite is at variance with the other species included in this paper. It is the only species with bicolored antennal flagellum and the only one from the Eastern United States. The type and only specimen is defective, an antenna, one wing and all the legs wanting.

NOTE:—Since the above has been written, three more specimens of this species have turned up in my collection. A male, Southern Pines, North Carolina, June, 1910, (A. H. Mance); a male and female specimen, Black Mountain, North Carolina, July, 1912, (Wm. Bentermueller).

Allotype, ♀, has the ovipositor elongated, testaceous and highly polished. The upper valves long and slender, pointed. The lower valves nearly four-fifths the length of the upper valves, obtuse at the apex.

Tipula fragmentata sp. n.

Reddish-brown with some lustre. Thoracic stripes distinct; ninth tergite rounded posteriorly, with a subtriangular prolongation from beneath the posterior margin. Pleural prolongation slender, twisted, strongly inclined proximad.

Male, length 11 millimeters, wing 13.5 millimeters.

Head dark, margin of orbits whitish. Frontal prolongation rather long, reddish-brown, shining, beset with black hairs. Nasus short, obtuse, with a tuft of white hair at the apex. Palpi brown. Scape and first flagellar joint of the antennæ pale yellow, second flagellar joint fuscous, remainder of antennæ wanting.

Thoracic stripes reddish-brown, with some lustre, separated by five yellowish lines of the ground color; the median stripe divided by a fine line. Pleura fuscous, dull. Scutum uniformly dark fuscous with a faint lustre. Scutel yellowish and like the yellowish-fuscous postnotum, shining. Legs slender, yellowish, femora yellow, apices fuscous; tibiæ and tarsi yellowish-fuscous. Halters yellowish, knob wanting. Wings grayish, stigma fuscous, the antestigmal spot faint interrupted in cell 1st, M2; a hyaline spot beyond the stigma.

Abdomen pale testaceous, shining, with median dorsal and lateral stripes, the latter somewhat interrupted; the median stripe does not extend upon the posterior tergites. Hypopygium (Plate XXX, Figs. 3 and 4) yellowish, pleural processes brownish. Ninth tergite rounded posteriorly and from beneath its posterior margin extends a subtriangular process or prolongation. Ninth sternite deeply emarginate, the emarginations almost entirely canceled by the narrowed end of the prolonged eighth sternite, the latter with a brush of hair at its apex. Pleural processes twisted, broad at the base, strongly attenuated and twisted outwardly, inclined towards each other. The outer apical appendage digitiform, extends obliquely inward.

Holotype, ♂, bears a label marked California (Bradley), Type C. U.

The specimen is in the collection of Mr. C. P. Alexander. It was received in alcohol and practically dismembered. In its hypopyginal characters, however, more especially the rounded ninth tergite, it is at once differentiated from all the other species. In its distinct thoracic stripes it resembles *streptocera*,* *trypetaphora* and *opisthocera*.

* A specimen, labeled *T. streptocera*, received from Prof. Doane, and another from my collection, determined by him, have the thoracic stripes nearly obsolete. The same is also the case in nearly all the specimens of this species in my collection.

Tipula monochroma spec. n.

Yellowish. Antennal flagellum unicolorous, fuscous. Thoracic dorsum brownish-yellow, dull. Prolongation of pleurite straight, stilletto-like, hairy.

Male. Length 11 millimeters; wing 12.5 millimeters.

Head concolorous; front and occiput gray, with a fine, dark median line. Frontal prolongation long, shining and like the nasus above, beset with short, blackish hairs. Palpi sordid yellow, last joint infuscate and scarcely longer than the preceding joints together. Antennæ moderate, the three basal joints yellowish, the remainder fuscous; segments subcylindrical, the basal enlargement blackish, each with a whorl of black, moderately long setæ.

Thoracic dorsum brownish-yellow; pronotal scutem darker about the middle. Praescutal stripes ill-defined by fine, paler lines. Scutum, scutellum and postnotum semiopaque, slightly more infuscate and somewhat sericeous. Pleura pale yellowish, sericeous. Legs yellowish, outer tarsal joints infuscate, the whole leg beset with coarse, short black hairs. Halters pale, club infuscate. Wings pale grayish; costal cells very pale yellowish; stigma pale, slightly infuscate. The antestigmal spot inconspicuous, extends through cell 1st M2 to base of cell M3, and sending a narrow, pale streak to the wing margin. The veins included in the antestigmal spot are whitish. Veins R and Sc. yellow, the other veins dark brown and delicate. The veins beyond the cord are indistinctly margined with subhyaline. The R, s, and the veins beyond the cord, except those limiting cell 1st M2, setulose.

Abdomen darker yellow, almost testaceous, shining; an ill-defined, more or less interrupted, fuscous dorsal stripe; tergites three to seven with a fuscous spot near the anterior angle and from which extends an indistinct streak along the lateral margin of the tergite. Venter with median blackish stripe, somewhat interrupted and obsolete beyond the fourth sternite. The eighth sternite projecting, narrowed posteriorly, the apical margin nearly truncate, with a brush of stiff, yellowish-fuscous, incurved bristles. Hypopygium (Pl. V, Figs. 7 and 8) dark testaceous, medium sized. The ninth tergite broad, slightly narrowed posteriorly, the free margin with small V-shaped, median notch, emarginate each side, the apical angles curved downwards. Ninth sternite with a rather deep, V-shaped emargination, from which projects a pencil of stiff bristles, lateral angles with a small appendage, beset with bristles. Pleural suture distinct. The pleural process has the shape of a stilletto, beset with hairs. The outer appendages are yellowish-white, membranous, bilaminate, somewhat protuberant and acuminate; the inner lamina beset with bristles, directed inwardly.

Holotype, ♂, Chimney Gulch, Golden, Colorado, (E. J. Oslar).

Paratype, ♂, Silver City, Nevada, June 3rd, 1913.

The paratype is paler than the holotype; the dark markings of the abdomen, with the exception of the lateral spots, nearly obsolete. The hairy stiletto-shaped pleural process of the male will readily distinguish this species.

Tipula trypetophora spec. n.

Yellowish, testaceous, shining. Antennal flagellum unicolorous. Thoracic stripes distinct. Wings faintly gray, veins beyond the cord broadly margined with hyaline. Pleural process conspicuous, long, twisted, nearly straight.

Male. Length, 13.5 millimeters; wings, 13.5 millimeters.

Head testaceous. Frontal prolongation and rostrum beset with short, black hairs. Palpi fuscous, the last joint scarcely as long as the preceding joints together. Front and occiput fuscous with an obscure, median darker line; the space surrounding the antennal insertion somewhat paler. Antennæ of moderate length; scapal joints pale yellow, first flagellar joint pale yellow at base, infuscate apically, the remaining joints fuscous, cylindrical, basal enlargement with the usual whorl of setæ, the latter shorter than the respective segments; pubescense whitish, very short; the last antennal joints rather strongly attenuate.

Thorax concolorous, shining. Pronotum scarcely darker in the middle. Praescutal stripes brown, well defined, the median stripe very little narrowed posteriorly, the lateral stripes abbreviated in front, extended upon the scutum, leaving a narrow external and internal margin of the ground color. Scutel and postnotum concolorous. Pleura with a pale sheen. Legs yellow, femora somewhat infuscate at the apex; tibiæ darker yellow; tarsi fuscous; tibiæ and metatarsi subequal; pilosity very dense, short, blackish. Halters sordid yellow, club infuscate. Wings grayish-hyaline, costal cells with a faint, yellowish tinge, stigma pale yellowish-fuscous. Veins brown, those beyond the cord broadly margined with hyaline. Cell 1st M2 fully two and one half longer than wide. The antestigmal spot more or less interrupted, extends into cell 1st M2, Rs. and veins beyond the cord, except Cu_1, setulose.

Abdomen concolorous; an ill-defined dorsal stripe, more distinct posteriorly; sides of tergites three to eight somewhat infuscate, three to five with a dark fuscous spot near the anterior angle. Venter with ill-defined, median darker stripe. The eighth sternite strongly narrowed and prolonged posteriorly, the apical angles with a small, triangular appendage; two narrow processes project from the middle of the posterior margin, the latter without a brush of hair. Hypopygium (Pl. V, Figs. 9 and 10) reddish-testaceous and rather large. The ninth tergite short, with narrow median incision, the apex of each side curved dorsad in the form of a small, obtuse tubercle, which is concave and shining on its posterior face. Ninth sternite short, broadly emarginate; pleural suture complete. Pleural process conspicuous, twisted at the base and within the latter arises a sharp, conical process; the direction of the process is nearly straight, caudad; apical appendages inconspicuous.

Female. Length 12.5 millimeters; wing, 13.5 millimeters. Flagellar joints two and three yellowish towards the apex, remainder of flagellum light brown. The lateral abdominal stripe distinct from tergite three to eight. Ovipositor short, concolorous, viewed laterally upper valves almost circular, lower valves elliptic, the upper margin ending in a very fine, spine-like prolongation.

Holotype, ♂, Victoria, British Columbia, July 6th, 1912.
Allotype, ♀, topotypic.
Paratypes, 1 ♂, 6 ♀ ♀'s, topotypic.

This species very closely resembles opisthocera. The wings are a trifle paler, likewise the stigma. The very different construction of the ninth tergite of the male, absolutely differentiates the two species. One male paratype has the thoracic stripes much less distinct.

Tipula opisthocera spec. n.

Testaceous; antennal flagellum unicolorous, fuscous. Thoracic stripes distinct. Pleural process conspicuous, strongly curved.

Male. Length, 12 millimeters; wing, 15 millimeters.

Head concolorous; frontal prolongation long, clothed with blackish hair, rather long on the nasus. Palpi brownish, the fourth joint darker and but little longer than the three preceding joints together. Face yellow. Antennæ slender, scapal joints yellow, first flagellar joint yellowish fuscous, joints subcylindrical, basal enlargement moderate with a whorl of rather long, black bristles; pubescense very fine, short, whitish. Front and occiput very dark fuscous, except near the base.

Thorax concolorous, shining. Praescutal stripes distinct, brown, rather broad and indistinctly margined with darker brown, the median stripe scarcely narrowed posteriorly, the lateral stripes much abbreviated in front, continued upon the scutum, where they leave but a narrow lateral stripe and a very narrow margin within, of the ground color. Scutellum and postnotum concolorous, lightly touched with fuscous. Pleura pale testaceous, with a faint, pale sheen. Legs yellowish-brown, densely clothed with brown hair; coxæ and base of femora paler, yellow; apices of femora and tibiæ fuscous, the latter longer than the metatarsi; tarsi fuscous. Halters concolorous, paler at base, club infuscate. Wings grayish with a fuscous tinge; vein M and all the veins beyond the cord broadly margined with hyaline; costal cells a very faint yellow; stigma brown; the antestigmal spot extends into the base of cell M3, is faint beyond cell R1; a hyaline spot beyond the stigma. Rs, vein M and the apical veins except those limiting cell 1st M2, strongly setigerous.

Abdomen testaceous, paler towards the base; a fuscous dorsal stripe extends from the second tergite to the end of the seventh, becoming more diffused posteriorly; tergum indistinctly margined with fuscous, more accentuated in a dark spot on the anterior angles of tergites three to seven, a faint median ventral stripe. The eighth sternite clasping cephalad, narrowed and somewhat prolonged posteriorly, the caudal margin rather deeply emarginate, with a triangular appendage at each angle of the emargination, the latter filled with a whitish membrane, which has the appearance as though it consisted of matted hair. Hypopygium (Pl. V, Figs. 11 and 12) reddish-brown; ninth tergite rather narrow, directed obliquely dorsad, somewhat turgid, with a very deep oval emargination, the lateral angles prolonged, turgid,

inclined inwardly, the inner margin with a large obtuse tooth and several smaller denticles. Ninth sternite very short, with slight medium notch. Pleural process long, somewhat flattened, twisted and appearing like an extended S. Apical appendages small and inconspicuous.

Female. Length, 12 millimeters; wing, 13.5 millimeters.

Antennæ shorter and more slender. Dorsal stripe of abdomen broader and more diffused posteriorly; the lateral stripes broad, strongly marked, tergites three to seven without lateral spots. Eighth segment entirely fuscous. Ovipositor dark testaceous, the upper valves short, quadrate-oval, dark brown; lower valves paler, very small, scaphoidal.

Holotype, ♂, Sonoma County, California, April 20th, 1914.

Allotype, ♀, topotypic.

Paratypes, 4 ♂♂'s, 3 ♀♀'s, topotypic.

A very distinct species. The ninth tergite of the male, with its deep, oval emargination, the sides thereof prolonged and strongly incurved with a large, obtuse point on its inner margin, distinguish this from the other species. The thoracic stripes are pronounced in all my specimens.

Tipula mutica spec. n.

Yellowish testaceous, shining. Antennal flagellum unicolorous. Thoracic stripes almost effaced. Pleural process twisted, curved, broad in basal portion.

Male. Length 12 millimeters; wing, 14 millimeters.

Head. Frontal prolongation and rostrum reddish-brown, with short, black hair. Palpi dark fuscous, joints two to four whitish at the base, the fourth joint scarcely as long as the preceding joints combined. Front and occiput grayish-fuscous, whitish along the upper orbital margin, a dark brown fronto-occipital stripe. Antennæ of moderate length, slender; first three joints pale yellow, remaining joints fuscous; basal enlargement of segments blackish with the usual whorl of setæ, the latter much shorter than the respective segments; pubescense fine, whitish.

Thorax concolorous, shining, the stripes faintly indicated, a shade darker than the ground color. Scutel and postnotum finely sericeous. Pleuræ pale yellow, faintly sericeous. Legs yellow, femora and tibiæ infuscate at the apex; the short, dense, black pilosity gives the legs a darker appearance; tibiæ distinctly longer than the metatarsi; tarsi fuscous. Halters pale fuscous, lighter towards the base, club dark fuscous. Wings pale gray, costal cells with a pale, yellow tinge, stigma pale yellowish-brown. Cell 1st M2 about twice as long as wide, veins brown, those beyond the cord broadly margined sub-hyaline, veins M and Cu less distinctly margined. The antestigmal spot is rather faint and does not extend beyond cell 1st M2; a faint hyaline spot beyond the stigma. R s, veins M, Cu, A_1 and apical veins setulose.

Abdomen testaceous, shining; a well marked dorsal stripe extends from the first to the eighth tergite, a lateral fuscous stripe more or less interrupted, extends from the third to the sixth tergite, more accentuated in a darker spot near the anterior angle of the respective segments. Eighth sternite prolonged and narrowed posteriorly, the posterior margin with a broad, rounded emargination which is filled with a whitish membrane; each angle of the emargination bears a large, triangular appendage, the inner margin of which has a brush of short, dense, golden-yellow hair. Hypopygium (Pl. V, Figs. 13 and 14) reddish, testaceous. The ninth tergite about as long as wide, broadly and deeply emarginate, the lateral angles prolonged as digitiform processes, slightly bent downward at the apex; the upper surface of the tergite with a median, longitudinal carina; viewed laterally, the upper surface appears subangulate about the middle. Ninth sternite short, with a median acute incision. Pleural suture complete, pleural process conspicuous, curved upward and markedly broadened just beyond the base, convoluted, then extending directly caudad and slightly bent outwardly. The outer apical appendages small, ovoidal, fringed with hair; the inner appendages a broad perpendicular lamina, extending above into an acutely pointed and strongly chitinized process; the lower margin strongly bearded with yellow, bristly hair.

Holotype, ♂, Somona County, California, May 21, 1914.
Paratypes, 4 ♀ ♀'s, topotypic.

The formation of the hypopygium alone must be depended on for differentiation from allied species.

Tipula streptocera-pallidocera var. n.

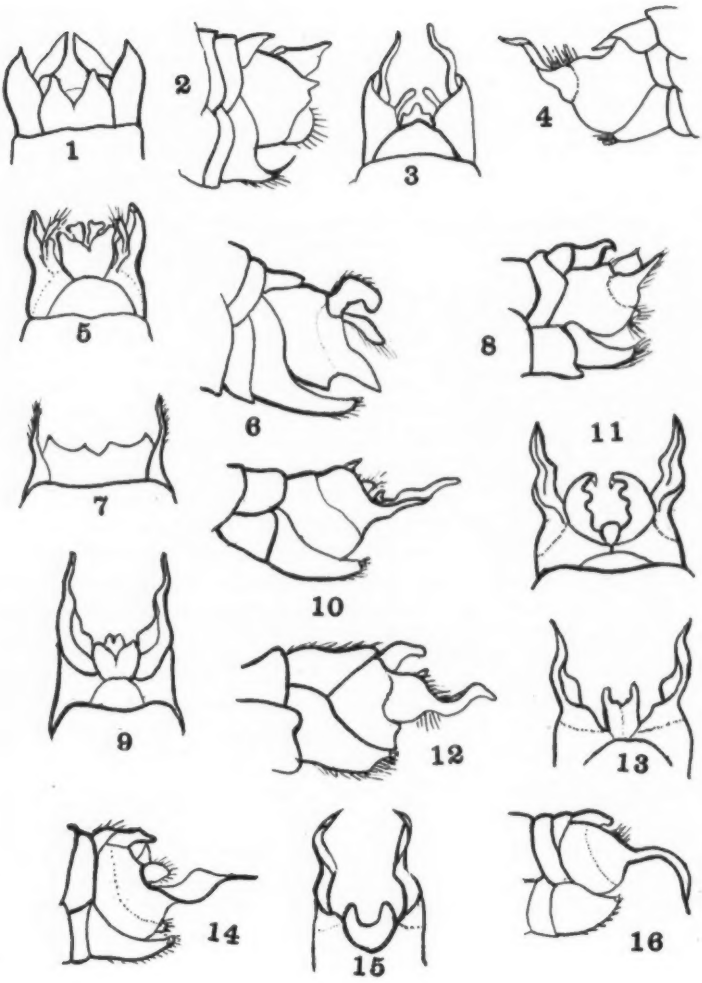
A specimen in my collection received from Prof. Doane and bearing the label "*L. streptocera,*" agrees in all details with the description and other specimens of this species, received or determined by its author, except that the antennæ are entirely pale yellowish. The thoracic stripes are ill defined.

Holotype, ♂, Keyport, Washington, July, 1905, (R. W. Doane).

EXPLANATION OF PLATE V.

Hypopygia.

Fig. 1. Dorsal aspect of *T. devia*.
Fig. 2. Lateral aspect of *T. devia*.
Fig. 3. Dorsal aspect of *T. fragmentata*.
Fig. 4. Lateral aspect of *T. fragmentata*.
Fig. 5. Dorsal aspect of *T. derbyi*.
Fig. 6. Lateral aspect of *T. derbyi*.
Fig. 7. Dorsal aspect of *T. monochroma*, without apical appendages.
Fig. 8. Lateral aspect of *T. monochroma*.
Fig. 9. Dorsal aspect of *T. trypetophora*.
Fig. 10. Lateral aspect of *T. trypetophora*.
Fig. 11. Dorsal aspect of *T. opisthocera*.
Fig. 12. Lateral aspect of *T. opisthocera*.
Fig. 13. Dorsal aspect of *T. mutica*, without apical appendages.
Fig. 14. Lateral aspect of *T. mutica*.
Fig. 15. Dorsal aspect of *T. streptocera*, without apical appendages.
Fig. 16. Lateral aspect of *T. streptocera*.



W. G. Dietz

LIFE HISTORY AND BIOLOGICAL NOTES ON CHLAENIUS IMPUNCTIFRONS SAY. (COLEOPTERA, CARABIDÆ).*

P. W. Claassen.

In the Proceedings of the Entomological Society of Washington I, 22, 1884, C. V. Riley says: "Perhaps one of the most interesting discoveries of the year 1884 is the mode of oviposition in some of our Carabidæ. From the terrestrial habits of most of our species one would expect that the eggs are deposited within the ground, and such may yet prove to be the case with many; but I have proved by actual breeding from eggs to the imago that it is not so with *Chlænius impunctifrons*, and have strong proof that *Chlænius æstivus*, *Scarites subterraneus* and the genera *Dicælus* and *Galerita* share with that species its singular mode of oviposition. The remarkable and unexpected fact, in insects so essentially terrestrial, is that the eggs are laid singly on the leaves of trees and shrubs and encased in a covering of mud or clay. I had often observed these little convex mud cells on the under side of leaves while collecting along the Mississippi in Missouri in years gone by, and was puzzled to make out their real nature. In May and June, 1883, while collecting on the Virginia side of the Potomac, I found these clay cells tolerably common and, fortunately, fresh, each containing a large soft white egg. That year I obtained larvæ, but only during the past year were any of these reared to the imago."

The above account is not accompanied by any figures or descriptions, and as far as I am aware, the life history of *Chlænius impunctifrons* has not been written hitherto.

On May 23, 1918, while collecting in the cat-tail marshes around Ithaca, New York, I observed a little ball of mud on the upper surface of a leaf of Typha. The mud ball occurred near the tip of the leaf, four to five feet above the surface of the ground. I took the leaf with the mud ball into the laboratory and upon breaking it open found a glistening white egg inside. Plate VI, Fig. 5. The egg was put into a tin salve box for rearing. The following day I found two more of the same kind of mud

* Contribution from the Department of Entomology, Cornell University.

cells, each on a Typha leaf near the tip. These two specimens also were brought to the laboratory and placed in the tin box with the other egg.

On May 28th the first egg had hatched. The young larva had opened one of the other mud balls and devoured the egg within. The third mud ball was then removed to another tin box. The first young larva died two days later, May 30th. That left only one egg of the lot. This egg hatched on the first of June, six days after it had been brought into the laboratory. The young larva was transferred to another clean tin salve box containing moist, sterilized sand.

Various kinds of food were offered to the young larva; larvæ and pupæ of *Lymnæcia phragmitella* Stainton, larvæ of *Nonagria oblonga* Grote, *Arsilonche albovenosa* Goeze, and *Arzama obliqua* Walk. Flies and fresh meat were also offered to the larva. At first the young larva fed somewhat on flies and on larvæ and pupæ of *L. phragmitella*, but it showed a decided preference for the little larvæ of *A. obliqua*.

During the second and third instar all other food was refused except larvæ of *A. obliqua*.

All the above mentioned Lepidoptera are inhabitants of Typha. *A. albovenosa* is an incidental surface feeder on the leaves; *L. phragmitella* lives in the heads of Typha, while *A. obliqua* and *N. oblonga* both begin their larval activities as leaf miners, later becoming solitary stem borers.

It is possible that the larvæ of *Chlænius impunctifrons* feed altogether on the larvæ of *A. obliqua*. The former hatch about the same time that the larvæ of the latter species leave the mines of the leaves of Typha to become stem borers. Thus while they are exposed they might easily fall prey to the Carabid larvæ.

On June 3, 11:00 A. M., the larva cast its first skin, the first instar having lasted three days. June 6, at noon, the larva molted again. The third instar larva had a voracious appetite and consumed many of the little *A. obliqua* larvæ. Five days later, June 11, the larva had tunneled into the moist sand and hollowed out a little cell. In this cell it was lying on its side as if ready to pupate. Having been disturbed the larva came to the surface of the sand and remained there, lying on its back. Whenever the box was opened it made efforts to turn over but was unable to do so. When turned over the larva crawled

about a little but soon fell over on its back again. In this condition the larva remained on top of the sand for sixteen days without taking any food. On June 27th the larva pupated. The pupa remained quietly on its back till July 4th, when the adult emerged. The adult was rather weak. The legs, especially the metathoracic legs, were not fully developed. The adult specimen was determined by Dr. J. C. Bradley.

TABLE OF INSTARS.

		LENGTH OF STAGE
Egg found	May 24	
Egg hatched	June 1	Egg stage 7 days plus?
First molt	June 3	First instar 3 days.
Second molt	June 6	Second instar 3 days.
Pupation	June 27	Third instar 21 days.
Emergence of adult	July 4	Pupal period 7 days.

DESCRIPTION OF STAGES.

MUD CELL.

(Plate VI, Fig. 5).

The little mud ball which encloses the egg is made of fine gray sand. It is placed singly on the upper surface of a Typha leaf six to eight inches from the tip. The mud ball is oblong oval, somewhat depressed. It measures 3.43 mm. in length, 2.28 mm. in width, and 1.75 mm. in thickness.

EGG.

(Plate VI, Fig. 1).

In the center of the mud cell occurs the egg. It is oblong oval, of a glistening white color, with rather large faint reticulations. It measures 2.28 mm. in length and 1 mm. in its greatest diameter.

FIRST INSTAR LARVA.

(Plate VI, Fig. 3).

Color. General color of larva dark brownish black, except in the less chitinized places which are grayish white. Head yellowish brown with a dark brown area in front between the epicraneal sutures. Antennæ and maxillary palpi dark brown, with a narrow yellow-brown ring at the joints.

Form. The body is elongate, tapering to both ends, but more posteriorly. The ninth abdominal segment bears two processes which equal the combined length of the pro- and mesothorax. The anal tube projects posterio-ventrad from the ninth abdominal segment.

Head. Head, excluding mouthparts and appendages, wider than long, narrowed behind the eyes. Dorsal surface slightly convex, with two short oblique grooves terminating at the lateral margin. Ventral surface more convex. Edge of labrum roughly toothed, with one larger tooth on each outer angle of the anterior margin. Surface of head smooth

with few hairs. Ocelli six, on a raised portion back of the antennæ. Antennæ four-jointed, the first and fourth joint about equally long; the second joint two-thirds the length of the first; the third joint slightly longer than first, with a crook above the middle. Two or three bristles originate from this outward crook or elbow, and one from the inner side. Fourth, or apical joint, with four bristles at the tip.

Mandibles long curved, with a strong tooth below the middle, directed inward and slightly downward. A small bunch of hairs near the inner base of mandibles.

Maxillæ with a long stout basal joint, bearing numerous hairs, especially on the inner and upper surface. Outer palpus four-jointed; first joint as wide as long, second joint somewhat more slender and at least twice as long; third joint slender and a little shorter than second; fourth joint as long as first, but very slender. Inner palpus two-jointed, the basal joint stouter and a little longer than second. Just inside the inner palpus is another small joint tipped with a bristle.

Mentum about as wide as long. Anterior margin produced to a point bearing two hairs. Palpus with basal joint little longer than broad; second joint little longer than first and tapering greatly.

Prothorax narrowing anteriorly, a third wider than long. Surface finely punctate.

Meso- and Metathorax each twice as wide as long.

Abdomen of nine true segments, gradually tapering posteriorly. The ninth segment bears the anal tube and the two posterior processes. These processes each bear five long stout hairs, three about equidistant along the process and two at the tip.

Legs long with stout hairs and two claws at the tip.

Measurements of Cast Skin. Length from tip of mandibles to tip of caudal processes, 7.43 mm.; greatest width across thorax, 1.26 mm.

SECOND AND THIRD INSTARS.

The second and third instar larvæ do not differ greatly in structure from the first except in size and proportions. The first instar is more spindle shaped. The body of the second and third instar is more flattened.

SECOND INSTAR LARVA.

(Plate VI, Fig. 7).

The second instar larva differs from the first in the following points.

Antennæ. First and third joint of equal length. Second and fourth joint subequal, each a little shorter than first and third joint.

Palpi of mentum with basal joint twice as long as broad; second joint as long as first.

Prothorax about twice as wide as long.

Meso- and Metathorax each more than twice as wide as long.

Caudal processes with four long hairs; one about half way back, another three-quarters back, and two at the tip.

Measurements of Cast Skin. Length from tip of mandibles to tip of caudal processes, 10.28 mm.; greatest width across thorax, 2.25 mm.

THIRD INSTAR LARVA.

(Plate VI, Fig. 4).

Antennæ. First, second and third joints of equal lengths. Fourth joint about two-thirds the length of the other segments.

Prothorax less than twice as wide as long, i. e., the width equals one and three-quarters the length.

Caudal processes as in the second instar.

Measurements of Cast Skin. Length from tip of mandibles to tip of caudal processes, 14.57 mm.; greatest width across throax, 3.43 mm.

PUPA.

(Plate VI, Fig. 2).

The pupa is of a creamy white color. The eyes are the first to show a mottled brown color. The mandibles also become chitinized early.

Ventral view. Head bent under so as to show a small portion of the prothorax. Labrum and clypeus together a third longer than broad, emarginate in front. Mandibles long with a notch and tooth at the apex. Maxillary and labial palpi plainly visible. Front of head with four setæ arranged as shown in figure. Antennæ eleven jointed, the tips almost reaching the tips of the metathoracic wings. Prothoracic legs extending to a point half way between the tips of the maxillary palpi and the tips of the antennæ. Mesothoracic legs underneath the antennæ, extending slightly beyond the tips of the antennæ. Metathoracic legs visible only at the tips where they project from beneath the metathoracic wings. Elytra show the longitudinal striæ plainly. The elytra extend about two-thirds the length of the metathoracic wings. Wings with a hump on the lateral margin. They extend back to a point one-third across the fourth abdominal segment. Abdomen with segments two to nine visible. Segment two with a small hair-tipped tubercle on each lateral margin. Segments three, four and five each with lateral processes as shown in the figure. Segments seven and eight smooth. Segment nine with two short posterior tubercles.

Dorsal view. Dorsally the pupa presents a hairy appearance. Long hairs occur on all but the last three abdominal segments. On the thorax the hairs are shorter and occur more scatteringly. On segments one to six, of the abdomen, the hairs are long and are arranged in two groups on each segment; one group on each side of the median line. The hairs are arranged in two more or less distinct rows, thirteen hairs in each lateral group, or twenty-six long hairs on each segment.

Measurements of the living pupa. Length, 10.28 mm.; greatest width of abdomen not including the lateral processes, 4.57 mm.

ADULT.

(Plate VI, Fig. 6).

The adult which emerged from the pupa in the laboratory measured 13.7 mm. in length and 4.7 mm. in its greatest width. The original description of the adult is found in the Transactions of the American Philosophic Society II, 64, 1823.

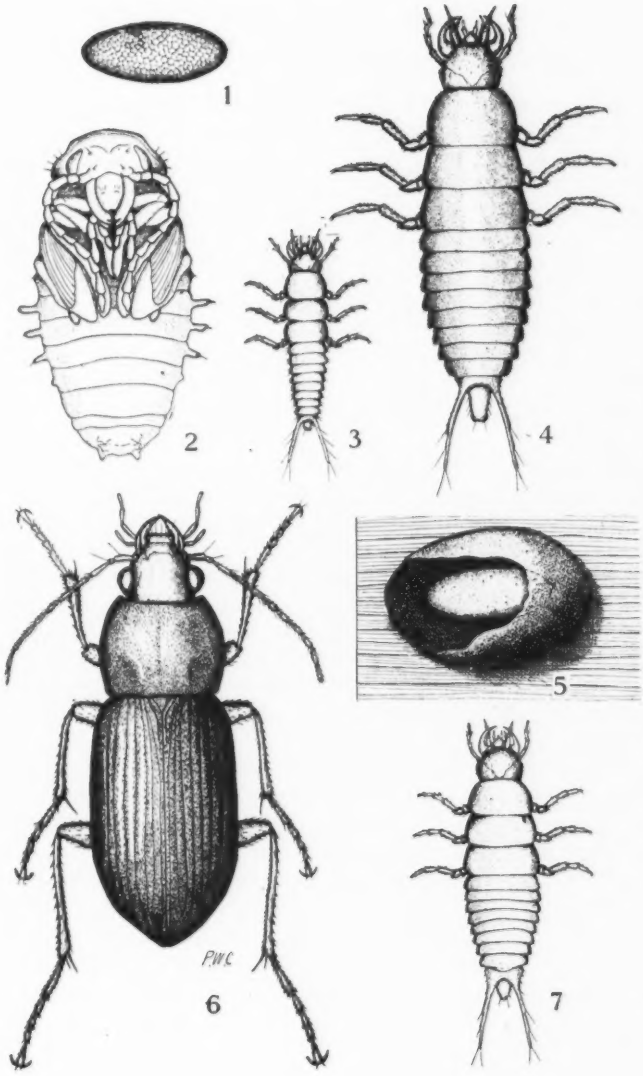
EXPLANATION OF PLATE VI.

Chlaenius impunctifrons Say.

Fig. 1. Egg, length 2.28 mm.
Fig. 2. Pupa, ventral view, length 10.28 mm.
Fig. 3. Larva, first instar, length 7.43 mm.
Fig. 4. Larva, third instar, length 14.57 mm.
Fig. 5. Mud cell on leaf. Opened to expose egg inside.
Fig. 6. Adult beetle, length 13.7 mm.
Fig. 7. Larva, second instar, length 10.28 mm.

Figures 2, 3, 4, 6 and 7 all drawn to the same scale.

P. W. Claassen, Del.



P. W. Claassen

ROBBERFLIES OF THE GENUS ERAX.*

JAS. S. HINE.

The species of this genus are flies of medium to large size. Their larvæ, so far as known, live in the soil and are predaceous, feeding on various forms of animal life present in such situations. The adults prey on many kinds of insect life, and with other genera of the same family may be considered as having the same relation among insects as hawks among birds.

Scopoli proposed *Erax* as a generic name in 1763 and included under it fourteen species. No genotype was proposed until 1910, when Coquillett designated one of Scopoli's species, *barbatus*, as the type. As matters stand at the present time all the species which Scopoli placed under *Erax* are located in other well established genera and the genus in his sense is left without a single representative.

In 1838 Macquart used *Erax* as a generic name. He gave Scopoli credit for the genus, but the characterization he used differs to such an extent that an entirely new group of species was admitted, and some of these have long been known as typical species of *Erax*. It is evident therefore, that opportunity for change of generic name is presented, but no action is taken because I am satisfied to use *Erax* in Macquart's sense and thus obviate the changes which another interpretation would involve. Since no genotype has been named for the genus in Macquart's sense, *Erax rufibarbis* Macquart is designated as the type of *Erax*. It is the twenty-second species in Macquart's arrangement in Dipt. Exot., I, 2, 107–119.

As an attempt has been made to associate and study all the North American species of the genus it was necessary to procure the loan of much material and to receive aid from various sources. A generous response has made it possible for me to do much more than could have been accomplished otherwise, and my appreciation is most cordially extended to the following institutions and students for services rendered:

Kansas University, Academy of Natural Sciences, National Museum, Carnegie Museum, Museum of Comparative Zoology, American Museum of Natural History, Biological Survey, Charles W. Johnson, J. M. Aldrich, Frederick Knab, Nathan

*Contribution from the Department of Zoology and Entomology, Ohio State University. No. 57.

Banks, J. C. Bradley, Charles Schaeffer, R. H. Beamer, C. P. Alexander, F. R. Cole and A. L. Lovett. Much material has been procured also by purchase or exchange from others who have expressed interest in the work.

Having at my disposal an extensive collection of the species of *Erax* from a wide range of territory in North America, a careful attempt has been made to properly identify the species concerned. Types have been studied in all cases where such were available. In some instances descriptions had to be used entirely and since some of these descriptions, of older authors especially, are brief and indefinite it is not impossible that oversights have occurred. The external male genitalia are used much in designating species. The vestiture of these organs obstructs one's view at times, but the dorsal part is less obscured than the ventral, so the former has been outlined more carefully, and is the part to which students are referred as an aid to specific determination.

It has not been possible to reach a conclusion in regard to the identity of some of the species so the following names are not included in the descriptive part of the paper:

Erax comatus Bellardi was not identified in the material studied. It belongs to the carinatus group and is described as 25 millimeters in length.

Erax aper Walker very likely belongs to the carinatus group also but it was not identified. It was described from Mexico and may be one of the species mentioned in the paper but its description is indefinite.

I consider *Erax pumilus* Walker and *Erax disjunctus* Williston the same as *Eristicus nigripes* Bellardi. This species is considered in Trans. Am. Ent. Soc. XLIII, 297, under *Eicherax nigripes*. The insect is not mentioned either by Osten Sacken or Williston in their works on Central American Diptera.

Erax pavidus Williston, from Mexico, appears to be well characterized but it was not identified in the material studied.

Erax lascivus Wiedemann, *Asilus amarynceus* Walker, *Asilus flavofasciatus* Wiedemann, *Asilus macularis* Weidemann and *Asilus antiphon* Walker, most likely are all species of *Erax*. They have been reported from North America and most of them from South America also. Records of their occurrences are meager and they have not been identified in recent years.

LIST OF NORTH AMERICAN SPECIES OF ERAX WITH SYNONYMY.

The **barbatus** Group.

armatus new species.
barbatus Fabricius, Syst. Antl., 169, (Dasypogon), 1805.
pogonias Wiedemann, Dipt. Exot., 198, (Asilus), 1821; Auss. Zw. I, 460, (Asilus), 1828.
albibarbis Macquart, Dipt. Exot. I, 2, 118, 1838.
cinerascens Bellardi, Saggio, II, 39, tab. II, fig. 10, 1861.
tricolor Bellardi, Saggio, II, 40, tab. II, fig. 12, 1861.
furax Williston, Trans. Am. Ent. Soc. XII, 67, 1885.
bicolor Bellardi, Saggio II, 47, 1861.
bimaculatus Bellardi, Saggio II, 45, tab. II, fig. 11, 1861.
cingulatus Bellardi, Saggio, II, 41, 1861.
grandis new species.
leucocomus Williston, Trans. Am. Ent. Soc. XII, 69, 1885.
quadrimaculatus Bellardi, Saggio, II, 44, tab. II, fig. 13, 1861.
sagax Williston, Biol. Centr. Am., Dipt., I, 324, 1901.
tagax Williston, Trans. Am. Ent. Soc. XII, 65, 1885.
similis Williston, Trans. Am. Ent. Soc. XII, 68, 1885.
willistoni new species.
zonalis new species.

The **aridus** group.

aridus Williston, North Am. Fauna, No. 7, 254, 1893.
harveyi new species.
prattii new species.
snowi new species.
subpilosus Schaeffer, Jr. N. Y. Ent. Soc., XXIV, 67, 1916.

The **anomalus** group.

anomalus Bellardi, Saggio, II, 32, tab. II, fig. 7, 1861.
candidus Coquillett, Can. Ent. XXV, 176, (Efferia), 1893.
pernicis Coquillett, Can. Ent. XXV, 175, (Efferia), 1893.

The **aestuans** group.

aestuans Linneaus, Syst. Nat. XII, II, 1007, (Asilus), 1767.
aestuans Fabricius, Syst. Antl., 164, (Dasypogon), 1805.
niger Wiedemann, Dipt. Exot., 196; Auss. Zw., I, 460, (Asilus), 1821.
macrolabis Wiedemann, Auss. Zw., I, 458, (Asilus), 1828.
aestuans Macquart, Hist. Nat. Dipt., I, 312, (Asilus), 1834.
incisuralis Macquart, Dipt. Exot., I, 2, 117, 1839.
bastardi Macquart, Dipt. Exot., I, 2, 117, plate 9, fig. 7, 1839.
tibialis Macquart, Dipt. Exot., I, 2, 118, 1839.
affnis Bellardi, Saggio, II, 41, 1861.
marginatus Bellardi, Saggio, II, 46, 1861.
apicalis Wiedemann, Dipt. Exot., 191 (Asilus), 1821; Auss. Zw., I, 443, (Asilus), 1828.
vicinus Macquart, Dipt. Exot., Supl. I, 85, 1846.
aurimystaceus new species.
belfragei new species.
femoratus Macquart, Dipt. Exot. I, 115, 1838.
fulvibarbis Macquart, Dipt. Exot., Supl. 3, 28, tab. 2, fig. 13, 1848.
haloesus Walker, List II, 405, (Asilus), 1849; List VII, 624, 1855.
kansensis new species.
loewii Bellardi, Saggio, Appendix, 21, tab. III, fig. 17, 1862.
dolichogaster Williston, Biol. Centr. Am., Dipt. I, 326, tab. 6, fig. 6, 1901.
mexicanus new species.

nigrimystaceus Macquart, Dipt. Exot., Supl. 2, 1847.
nigritarsis new species.
portoricensis new species.
rufitibia Macquart, Dipt. Exot., Supl. 3, 42, tab. II, fig. 11, 1848.
fortis Walker, List. VII, 623, 1855.
slossonæ new species.
stylatus Fabricius, Syst. Ent. 795, (Asilus), 1775.
haitensis Macquart, Dipt. Exot., Supl. 3, 28, tab. II, fig. 10, 1848.
caudex Walker, List II, 404, (Asilus), 1849.
invarius Walker, Ins. Saund., Dipt. I, 131, 1851.
***tabescens** Banks, new species.

The **carinatus** group.

carinatus Bellardi, Saggio, II, 36, tab. II, fig. 9, 1861.
comatus Bellardi, Saggio, II, 34, 1861. Not identified in my material.
concinnatus Williston, Biol. Cent. Am., Dipt. I, 323, 1901.
costalis Williston, Trans. Am. Ent. Soc., XII, 64, 1885.
cressoni new species.
jubatus Williston, Trans. Am. Ent. Soc., XII, 66, 1885.
prolificus Osten Sacken, Biol. Cent. Am., Dipt. I, 202, 1887.
latrunculus Williston, Trans. Am. Ent. Soc., XII, 67, 1885.
parvulus Bellardi, Saggio, II, 35, tab. II, fig. 8, 1861.
subcupreus Schaeffer, Jr. N. Y. Ent. Soc., XXIV, 66, 1916.
unicolor Bellardi, Saggio, II, 37, 1861.

The **tuberculatus** group.

productus new species.
spiniventris new species.
tuberculatus Coquillett, Jr. N. Y. Ent. Soc., XII, 34, 1904.

The **rufibarbis** group.

bicaudatus new species.
rufibarbis Macquart, Dipt. Exot., I, 2, 116, 1838.
aestuans Wiedemann, Dipt. Exot., 200, (Asilus), 1821, (not *Linneaus*); Auss. Zw., I, 467, (Asilus), 1828.
completus Macquart, Dipt. Exot., I, 2, 117, tab. IX, fig. 9, 1838.
dascyllus Walker, List II, 401, (Asilus), 1849.
virginianus van der Wulp, Tijdschr. v. Entom. XXV, 109, tab. X, figs. 5 and 6, (*Proctacanthus*), 1882.
ravus Coquillett, Canadian Entomologist, XXV, 176, (*Efferia*), 1893.

The **stramineus** group.

argentifrons Hine, Ohio Naturalist, XI, 308, 1911.
argyrogaster Macquart, Dipt. Exot., supl. 1, 84, 1846.
argyrosoma Hine, Ohio Naturalist, XI, 310, 1911.
auripilus Hine, Ohio Jr. Science, XVII, 22, 1916.
aurivestitus new species.
californicus Schaeffer, Jr. N. Y. Ent. Soc. XXIV, 67, 1916.
canus Hine, Ohio. Jr. Sci. XVII, 22, 1916.
coquillettii new species.
dubius Williston, Trans. Am. Ent. Soc., XII, 64, 1885.
eximeus Bellardi, Saggio, II, 38, 1861.
inflatus Hine, Ohio Naturalist, XI, 310, 1911.

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* Among a number of species received from the Museum of Comparative Zoology were two species which Dr. N. Banks had named and the descriptions in manuscript were turned over to me. The two species are Erax tabesuns and Erax texanus, and Dr. Banks is credited with these, although they are published for the first time in this paper.

interruptus Macquart, Hist. Nat. I, 310, (Asilus), 1834.
maculatus Macquart, Dipt. Exot., I, 2, 111, tab. IX, fig. 6, 1838.
lateralis Macquart, Dipt. Exot., I, 2, 116, 1838.
ambiguus Macquart, Dipt. Exot., supl. 1, 84, 1846.
villosus Bellardi, Saggio, II, 49, (*Eristicus*), 1861.
nemoralis Hine, Ohio Naturalist, XI, 311, 1911.
pallidulus Hine, Ohio Naturalist, XI, 309, 1911.
pilosus new species.
plenus Hine, Ohio Jr. Sci., XVII, 21, 1916.
rapax Osten Sacken, Biol. Centr. Am., Dipt., I, 201, 1887.
splendens Williston, Biol. Cent. Am., Dipt., I, 325, tab. VI, fig. 5, 1901.
stramineus Williston, Trans. Am. Ent. Soc., XII, 68, 1885.
texanus Banks, new species.
triton Osten Sacken, Biol. Centr. Amer., Dipt., I, 200, 1887.
truncatus Hine, Ohio Naturalist, XI, 309, 1911.
varipes Williston, Trans. Am. Ent. Soc., XII, 71, 1885.

KEY TO GROUPS OF ERAX.

1. Furcation of the third vein distinctly before the base of the second posterior cell making the second submarginal cell long.....2
   Furcation of the third vein opposite or beyond the base of the second posterior cell.....4
2. Three submarginal cells.....The **anomalus** group
   Two submarginal cells.....3
3. Rear of thorax and scutellum with abundance of bristles, male abdominal segments six and seven silvery, female with tip of oviduct from above furcate.....The **rufibarbis** group
   Male abdomen usually with several segments silvery, female with tip of oviduct from above never divided. Male, except in a very few cases, with one or more abdominal segments bearing long white hair parted at the middle and directed outward.....The **stramineus** group
4. Posterior branch of the third vein curved backward at tip, meeting the costa at or beyond the apex of the wing.....The **aestuans** group
   Posterior branch of the third vein curved forward, meeting the costa plainly before the apex of the wing.....5
5. Mesothorax compressed, anteriorly and with a conspicuous crest of erect hairs on the mid-dorsal line.....The **carinatus** group
   Mesothorax broadly rounded above and without a conspicuous crest of hairs..6
6. Mesothorax with numerous bristly hairs which are unusually long, scutellum conspicuously hairy and with numerous marginal bristles..The **aridus** group
   Mesothorax with very short hair anteriorly, a few rather prominent bristles posteriorly. Scutellum with short hair on the disc and usually with not more than half a dozen bristles on its margin.....7
7. Male with ventral prominences on abdominal segments four, five and six, small slender species.....The **tuberculatus** group
   Male abdomen without ventral prominences usually large or medium sized, robust species.....The **barbatus** group

The **barbatus** Group.

The members of this group have a broad mesothorax, quite evenly curved, short-haired all over, especially anterior to the transverse suture. Only a few prominent bristles above the attachment of the wings and posteriorly. Scutellum short-haired on the disc, and usually with not more than half a dozen bristles on the margin, although occasional specimens may have one or two more than this number, in most cases there are less. Branching of the third vein never anterior to the base of the second posterior cell, occasionally it is opposite the base of this cell, but in nearly all cases it is plainly beyond, making the second submarginal cell short. The posterior branch of the third vein bends forward, and reaches the costa distinctly before the apex of the wing.

In some species the male has the costa thickened and expanded on the anterior margin, somewhat before the apex, but in other species this is not the case.

A species which is typical of this group is what in recent years has been called *albibarbis*, but here it is considered the same as *barbatus* which is an older name as indicated in the list of species on another page.

1. Hypopygium small or of normal size, medium sized to small species, usually of slender build, male costa not at all or only very slightly expanded, female with each abdominal segment black, with posterior gray border of various widths according to species.....2
   Hypopygium distinctly enlarged, large to very large species, male costa rather conspicuously thickened and expanded, female abdomen variously marked, but usually the segments are not black with posterior gray borders, although this is the case in at least two species.....5
   Hypopygium distinctly enlarged, costa not at all thickened and expanded, mystax straw yellow in both sexes, bristles of the thorax and scutellum pale, abdomen uniformly yellowish gray pollinose, male with the apical abdominal segments partly or wholly silvery.....**leucocomus** Williston
2. Gray bands of the abdomen regular and wide, approaching the width of the black intervals between them, hypopygium red.....**zonatus** n. sp.
   Hypopygium black, gray abdominal bands irregular or very narrow.....3
3. Mystax pale, sometimes with a few black bristles on upper margin, **barbatus** Fabr.
   Mystax largely black with pale hairs and bristles intermixed.....4
4. Sixth and seventh segments of male abdomen silvery, pale bands of the abdomen brownish gray, with front margin more or less irregular, **cingulatus** Bellardi
   Fifth, sixth and seventh segments of male abdomen silvery; pale bands of the abdomen silvery, regular and narrow.....**willistoni** n. sp.
5. Male hind tibiae with an abnormal enlargement.....6
   Male hind tibiae normal.....8
6. Wings quite distinctly brown.....**sagax** Williston
   Wings hyaline.....7
7. Apical third of the male tibia enlarged.....**tagax** Williston
   Apical half or more of male tibia enlarged.....**armatus** Hine
8. Male seventh abdominal segment entirely silvery dorsally; female fifth abdominal segment not silvery.....9
   Male seventh abdominal segment clear black on the greater part of the dorsum; female fifth abdominal segment broadly silvery on each side, with a black stripe on the middle of the dorsum.....10

9. Wings hyaline, not unusually large.....**bicolor** Bellardi
   Wings brownish, especially toward the apex; very large species..**grandis** n. sp.
10. Mystax straw yellow with a few black bristles above, wings pale yellowish brown.....**bimaculatus** Bellardi
    Mystax black with a few pale bristles intermixed; wings fuscous, more apparent towards the apex.....**quadrimaculatus** Bellardi

Erax barbatus Fabricius.

Length 13 to 20 millimeters. Male. All vestiture of the head white to pale yellowish. Quite often a few black bristles in the mystax and occasionally on the palpi. Thorax pale pollinose, not always of the same shade, markings very obscure, anteriorly with short pile variable in color, posteriorly with a number of black pale bristles. Scutellum with sparse pale pile on the disc and a few black or pale bristles on the margin. Femora black in ground color obscured by white pollen and hair, apex of each tibia and whole of tarsi largely black, tibiæ otherwise pale yellowish, bristles of the legs variable from black to pale, wings slightly yellowish, nearly hyaline, costa not dilated, anterior branch of the third vein with a distinct stump variable in length in different specimens, basal section almost in direct line with the cross vein at the base of second posterior cell. Abdomen dorsally, first and second segments pale pollinose, usually a rather small rounded blackish spot on each side of the second; third, fourth and fifth largely black with posterior margins and often median stripe pale pollinose; sixth and seventh silvery. Hypopygium black. See Figures 2 and 8.

Female colored like the male, abdominal segments six and seven colored like the preceding in most cases, but sometimes the segments are nearly wholly gray pollinose, oviduct shining black.

This species is the most widely distributed of any of the genus. It ranges from Guatemala and Lower California to Washington and New England and often is the first of the genus taken in any locality within its range.

The uniform color of the thorax without apparent markings and the two rows of black spots on the abdomen make its determination easy. Although the two longitudinal rows of black abdominal spots are present in most cases there is variation, some specimens having these spots much reduced while others have them enlarged until nearly the whole abdomen is black. The two basal segments, however, most always are uniformly gray and the other segments have at least a narrow middorsal stripe and posterior border on each, the same color.

The possibility of more than one species in the material used has been considered but it does not appear possible to find characters for satisfactory separation, so it is preferable to include all in a single species.

Erax bicolor Bellardi.

Total length 21 to 26 millimeters; vestiture of the head largely yellowish white, some black bristles in the mystax; bristles of the palpi almost wholly black. Whole body nearly uniformly gray pollinose, mid-dorsal stripe of the thorax quite plainly black and divided lengthwise by a gray interval. In some specimens rather obscure darker spots on some of the abdominal segments. Wings hyaline costal border dilated, furcation of the third vein plainly beyond the base of the second posterior cell, basal three-fourths or more of the tibiæ pale yellowish, otherwise legs black with black bristles. Sixth and seventh abdominal segments silvery, hypopygium large and black. See Figure 9.

Female colored like the male, except abdominal segments six and seven are velvety black. Oviduct black, about as long as segments four to seven.

Habitat: Mexico, Texas, Mississippi, New Mexico and Arizona. Twenty-four specimens.

Bellardi described the species from a female and mentioned the black sixth and seventh abdominal segments which seems to be a peculiarity of this species. It is more evident in some specimens than others.

Erax willistoni n. sp.

Male. Total length 22 millimeters. Very dark colored species; mystax black with a few pale hairs intermixed, beard white, palpi with black bristly hairs. Thorax thinly gray pollinose, mid-dorsal stripe and irregular spots on either side black, with black hair and bristles, scutellum gray pollinose with pale hairs on the disc and about eight black bristles on the margin. Wings nearly hyaline, very slightly tinged with brown on apical half; costa somewhat dilated, branching of the third vein beyond the base of the second posterior cell, stump very short. Legs with black bristles and pale hairs, extreme apexes of femora, tibiæ and tarsi entirely dark reddish brown, remainder of femora black. Abdominal segments two, three and four black above, narrow posterior margin and sides gray pollinose, segments five, six and seven silvery, hypopygium elongate, emarginate at apex, black with black vestiture. See Figure 7.

Female. Total length 23 millimeters. Colored like the male with segments five, six and seven like those that precede them, ovipositor black, as long as the last four abdominal segments.

Type male and allotype, on the same pin, collected at Williams, Arizona, July 21, by H. Barber. Deposited in the U. S. National Museum. Five other specimens from Colorado, Arizona and Chihuahua, Mexico, by Tucker, Barber and Townsend.

This species looks like æstuans but the wing venation, color of the legs and the male genitalia characterize it. It is the only species of its group with the femora reddish brown at the apexes although some specimens do not show the character very plainly.

Erax cingulatus Bellardi.

Total length 20 to 25 millimeters. Male. Mystax largely black, but intermixed with pale yellowish hairs; beard pale yellowish; palpi with numerous black bristly hairs. Much of the thorax and abdomen brownish pollinose, thorax with a wide mid-dorsal stripe and spots on either side black, vestiture mostly black, but a few pale hairs posteriorly, scutellum and extending to the posterior part of the mesothorax ash gray, conspicuously contrasting in color with the rest of the thorax, wings tinted with brownish, costa very slightly dilated, furcation of the third vein distinctly beyond the base of second posterior cell, stump shorter than the basal section, three-fourths or more of tibiæ from bases, pale yellowish, otherwise legs black, except some of the basal tibial segments which are dark brown. Some of the bristles of the legs are pale in some specimens, but most of them are black, abdominal segments two, three, four and five black anteriorly and pale brownish pollinose posteriorly, the divisions between the colors irregular and not sharply defined, segments six and seven silvery. Hypopygium black with black vestiture, rather large. Figure 34.

Female colored like the male except abdominal segments six and seven are like those that precede them. Ovipositor black, slightly longer than the last three abdominal segments.

Seven specimens from Cuernavaca, Mexico, collected by D. L. Crawford.

The ash-colored scutellum and space before it contrasting with the rest of the thorax is characteristic of this species, but only well preserved specimens show it. There are only two to four black bristles on the margin of the scutellum.

Erax grandis n. sp.

Male. Total length 33 millimeters. Mystax composed of numerous yellowish gray hairs and black bristles, beard pale yellowish gray, palpi with black and pale hairs, thorax gray pollinose with unusual markings, scutellum with black hairs on its disc and four black bristles on its margin, femora, apexes of tibiæ and tarsi black, remainder of tibiæ pale yellow, wings slightly brownish, costa distinctly dilated, furcation of third vein plainly beyond the base of the second posterior cell, stump very short, two, three, four and five abdominal segments black above, with narrow posterior margin and sides gray, segments six and seven silvery. Hypopygium large, black with black vestiture.

Female. Total length 31 millimeters with tip of ovipositor broken off, probably 34 or 35 millimeters when complete, colored like the male, but segments six and seven not silvery, stump of the anterior branch of the third vein much longer than in the other sex.

Type: Male and allotype, from Round Mountain, Texas, deposited in the museum of the Philadelphia Academy of Natural Sciences.

This is the largest *Erax* I have ever seen. It suggests bicolor but aside from its being much larger the costa is more strongly dilated, the disc of the scutellum has black hair instead of white, and the male genitalia are different.

Erax zonatus n. sp.

Male. Total length 16 millimeters. Vestiture of the head largely white, several black bristles in the mystax and numerous black hairs on the palpi. Tibiæ red except at extreme apex, tarsi largely red, but somewhat darker than the tibiæ and furnished with numerous black bristles, femora black. Thorax quite uniformly yellowish gray pollinose with the usual marking very obscurely shown. Wings very slightly tinged with yellowish, nearly hyaline, costa just a little dilated, branching of the third vein plainly beyond the base of second posterior cell, stump slightly longer than the basal section. Abdomen with four black bands as follows: One on the middle of the second segment and one on each anterior margin of segments three, four and five. These black bands all are wider than the gray bands following them. Segments six and seven silvery. Hypopygium red, prominent ventrally, more so in appearance because of a ventral tuft of chestnut brown hairs.

Female. Total length 18 millimeters. Colored like the male except the sixth abdominal segment is banded with black like five, and seven is black with a very narrow gray posterior margin, ovipositor black, about as long as abdominal segments five, six and seven.

Type: Male and allotype from Southern Arizona, F. H. Snow, August, 1902. Collection of the author. Ten other specimens, some of them from the collection of the Academy of Natural Sciences, Philadelphia. Habitat, San Antonio Canyon, California, Southern Arizona and Alamogordo, New Mexico.

Easily known from all species of its group by the zonate appearance of the abdomen, and the prominent array of ventral hairs on the hypopygium, most conspicuous basally.

Erax armatus Hine.

There are three species of Erax with the hind tibiæ modified in the male. All are larger than the average. In the male the furcation of the third vein is beyond the base of the second posterior cell, while in the females it is usually about opposite the base of that cell. Stump

of the anterior branch always present. The females are easily associated with the males, but have no very good characters for distinguishing them from others of the same sex. The wings are hyaline in armatus, at least the yellowish tinge is hardly evident. The tibia of the male shows an angular prominence posteriorly, somewhat nearer its base than its apex, the female has the first five abdominal segments rather densely gray pollinose, with rounded black spots above on two, three, four and five; segment six is nearly all black above and seven is entirely black. Femora, tarsi and apexes of tibiæ black, basal three-fourths or more of each tibia pale yellow. Total length 30 to 32 millimeters.

Ten specimens from Davis Mountains (F. M. Gaige) Cotulla (F. C. Pratt) and Uvalde, Texas. Taken in June and July.

Erax sagax Williston.

Total length 25 to 27 millimeters. Wing wide and conspicuously light brown all over in both sexes; male with the hind tibia suddenly enlarged beyond the middle of its length; both sexes with silvery markings on the abdomen. In the male, segments two and three are narrowly silvery on the sides, four, five and six are largely silvery, but four has a rather large black triangular spot above and five has a narrow black marking above anteriorly, six entirely silvery, seven black above with narrow sides silvery.

Female with segments two, three, four and five silvery at the sides; this color is extended dorsally on the hind margin of three and on the whole of four and five, but in no case does it meet above so there is a conspicuous black space left dorsally on each segment; six and seven nearly entirely black. The femora are red apically in both sexes, and posteriorly in the female, in the specimens at hand.

Three specimens from Guadalajara, Mexico, June 24, 1903, collected by McClendon.

Erax tagax Williston.

Total length 28 to 30 millimeters. Wing very pale brownish. Male hind tibia with a distinct prominence posteriorly near distal third and a conspicuous patch of black pile anteriorly just opposite and extending to apex. Abdominal segments of the male two, three, four and five black with narrow sides and posterior margin silvery white pollinose, six wholly silvery, seven mostly silvery, but with posterior margin above dark. Female, segments two, three, four, five and six black, with sides and narrow posterior margin white pollinose, seven black, oviduct black not much longer than abdominal segments six and seven. Femora black in the male and mostly redish posteriorly in the female in the specimens at hand.

A dozen specimens from Arizona.

There is no record that *Erax similis* has been recognized since it was described by Williston and we have good reason to believe that it is the female of *tagax*.

Erax leucocomus Williston.

A large pale species with bristles and hairs of head, thorax and abdomen all pale yellowish; legs usually with black femora and black bristles throughout; wings delicate yellowish, veins quite distinctly yellow on the basal part. Total length 25 to 30 millimeters. Male wing with the furcation of the third vein beyond the base of the second posterior cell, stump about as long as the basal section, costa not dilated in the least. Hypopygium large from dorsal view gradually widened toward the tip, where it is much wider than in other species of its group. The abdomen in both sexes is pale yellowish gray without markings, but somewhat changeable according to the direction from which it is viewed. In the male, segments six and seven may be said to be silvery and in the female segment seven is somewhat darker than the others. Oviduct black. Nearly as long as the last three abdominal segments.

Ten specimens from Western Kansas, collected by F. X. Williams and one from Dallas, Texas, taken September 5, 1905, by F. C. Bishop.

The species is very distinct and readily recognized but appears to be rare and I had two species questionably referred to *leucocomus* before I procured it. It would not be strange if some specimens would have some black bristles on the body. It is well adapted to life on the sand on account of its color.

Erax quadrimaculatus Bellardi.

Total length 28 to 34 millimeters. Mystax rather sparse, composed largely of black bristles with a few pale ones and pale hairs intermixed, beard nearly white. Whole body black and appearing darker than other species of Erax. Thorax very sparsely gray pollinose with black bristles and hairs, scutellum with short black hairs on the disc and two to four black bristles on the margin; femora, tarsi and apexes of the tibiæ black, remainder of tibiæ pale yellow, wings uniformly fuscous all over, costa only slightly dilated in the male, furcation of the third vein clearly beyond the base of the second posterior cell. In the male abdominal segments two, three, four and five with sides narrowly gray pollinose, extended dorsally on the posterior margin of each, but not uniting across the dorsum; segment six silvery on each side, widest before leaving a black dorsal triangular spot with its base on the posterior margin; segment seven similar, but the silvery areas much reduced and the black consequently extended. Female segments two, three and four as in the male, five conspicuously silvery on each side, black on the mid-dorsum; six and seven velvety black, oviduct black, hardly as long as abdominal segments five, six and seven.

Several specimens from Colombia, South America, from the Carnegie Museum of Pittsburgh. Other specimens from Mexico.

Erax bimaculatus Bellardi.

Total length 25 to 28 millimeters. Mystax and beard pale yellow, the former with a few black bristles above; thorax brown pollinose with the usual markings; wings yellowish, costa of male distinctly dilated, femora black, remainder of legs yellowish red with black bristles. Abdomen colored much as in quadrimaculatus in the male segments four and five entirely silvery, or at most with a very narrow mid-dorsal stripe, segment seven silvery on front margin and on the sides, black otherwise, female with abdominal segments two, three and four white pollinose on the sides, fifth white with the exception of a mid-dorsal stripe, sixth and seventh velvety black, oviduct shining black.

The yellow mystax and beard readily separates this species from *quadrimaculatus*. The two species are entirely distinct although similarly colored.

Several specimens from Guadalajara, Mexico, collected by McClendon, and from Cuernavace, Mexico, collected by D. L. Crawford.

The **aridus** Group.

A few species from the more or less arid regions of western United States are much like members of the stramineus group, but the branching of the third vein is almost exactly opposite the base of the second posterior cell. The following key may be used to separate the species.

1. Mystax straw yellow 2
   Mystax white 3
2. Male abdominal segments six and seven, silvery ..... **harveyi** n. sp.
   Male abdominal segments four, five, six and seven silvery. Four more or less black on the mid-dorsal line ..... **snowi** n. sp.
3. Hypopygium from dorsal view plainly widened towards apex where it is distinctly wider than at base ..... **prattii** n. sp.
   Hypopygium not or but very slightly wider at apex than at base 4
4. Bristles of the body and legs nearly all white, male first and second abdominal segments black hairy ..... **subpilosus** Schaeffer
   Male first and second abdominal segments white hairy ..... **aridus** Williston

Erax harveyi n. sp.

Male. Total length 18 millimeters. Mystax, beard, ocellar and occipito-orbital bristles pale straw yellow, palpi black and yellow haired, anterior part of dorsum of mesothorax black haired, remainder of thorax with pale vestiture, scutellum with numerous pale yellow marginal bristles; wings hyaline, furcation of the third vein exactly opposite the base of the second posterior cell, stump about as long as the basal section; legs faded reddish, mostly with pale vestiture, but an occasional black bristle, femora quite distinctly darker than the other parts. Abdomen pale haired all over, general color dark, thinly

gray pollinose, more dense in some places than others giving a mottled appearance from some views; sixth and seventh segments silvery, hypopygium rather small, dark colored from dorsal view, sides nearly parallel, angular at extreme apex.

Female. Total length 21 millimeters. Colored like the male. Sixth and seventh abdominal segments, from side view, wedge shaped at tip, from dorsal view not furcate apically.

Type: Male and allotype, from Vernon, B. C., August 11 and 15, 1904. Collected by the late Captain R. Valentine Harvey for whom the species is named.

This species suggests *bicaudatus* but the structure of the oviduct is very different and the second submarginal cell is shorter.

Erax snowi n. sp.

Male. Total length 22 millimeters. All the bristles of the head except four bristles near the ocelli pale yellowish tinged, thoracic dorsum and disc of scutellum black hairy, bristles near the wing roots and on the margin of the scutellum pale yellowish, pleuræ with pale hair, legs largely black with abundant long pale hair and black and pale bristles, basal half of each front and middle tibia and basal fourth of each hind tibia reddish, although not conspicuously so. Wings faintly yellowish hyaline, furcation of the third vein nearly opposite the base of the second posterior cell, stump about the length of the basal section, first three abdominal segments mostly black, thinly yellowish pollinose laterally, with black hair above and pale yellowish and rather long hairs at the sides; fourth segment narrow black before and on the middle of the dorsum, white pollinose and long white haired laterally, fifty, sixth and seventh segments silvery and with a few short white hairs. Hypopygium black, mostly with pale vestiture, of medium size.

Female. Size and coloration very nearly as in the male. Abdomen entirely yellowish gray pollinose and pale haired, from some views more or less shining; oviduct black, scarcely as long as the last three abdominal segments.

Type: Male and allotype, from Clark County, Kansas, 1962 feet elevation, taken in May by F. H. Snow, for whom the species is named. In the author's collection. More than fifty other specimens from Kansas, Colorado, New Mexico and Texas, show some variation in size, and a little in color of bristles, but may be said to be quite uniform.

Some specimens have more black bristles on the posterior part of the mesonotum and on the margin of the scutellum than the type.

The color of the abdomen distinguishes the species from all others except *plenus* which has very different male genitalia.

Erax aridus Williston.

The female type of aridus is in the National Museum. There does not appear to be any male specimens at hand. The species is peculiar in being very hairy and bristly and Williston described it as belonging near latrunculus, but it surely is very distinct from that species. True there is a row of rather long black hairs in the middle of the anterior part of the dorsum of the mesothorax, but the thorax is not compressed and it is almost sure that when the male of aridus is finally located it will not have a dilated costa which is always present in the carinatus group. Palpi with black hair, vestiture of remainder of head pale, mesothoracic dorsum with black hair, scutellum with light hair, bristles near the wing bases pale, pleuræ pale haired, legs with abundance of long pale hairs, and mostly pale bristles, legs black, base of each tibia with just a suggestion of reddish, wings hyaline, furcation of the third vein nearly opposite the base of the second posterior cell, stump distinctly longer than the basal section, abdomen black, gray pollinose, more plainly so laterally and on the narrow posterior border of each segment. Oviduct black, short, only a little longer than the last two abdominal segments.

The short oviduct readily separates *aridus* from what is considered as the female of *subpilosus* a nearly related species. For a time the possibility of the type of *subpilosus* being the male of *aridus* was considered but there seems to be good reason for separating them as distinct. Length about 25 millimeters.

Williston's type was taken by the Death Valley Expedition in April, 1891.

Erax prattii n. sp.

Male. Total length 16 millimeters. Mystax and beard white, palpi with black bristles, front mostly with pale hairs, several bristles near the ocelli, some black and the others yellow, occipito-orbital bristles pale yellowish. Bristles and hairs of the mesothoracic dorsum black, pleuræ white hairy; legs abundantly long white hairy and with black and pale bristles, femora black, tibiæ and tarsi mostly pale brownish; wings hyaline, costa not at all dilated, branching of the third vein almost exactly opposite the base of the second posterior cell, stump scarcely as long as the basal section. Abdominal segments one to five inclusive black, each with a narrow gray border of uniform width, segments six and seven silvery. Hypopygium from dorsal view gradually widened from base to apex, where it is nearly truncate and distinctly wider than in most other species. See Figure 13.

Male type from Laredo, Texas, November 25, 1905. Collected by F. C. Pratt, from whom the specimen was procured. Collection of the author.

The size and the width of hypopygium make it easy to determine this species.

Erax subpilosus Shaeffer.

Male. Length 22 millimeters. Head grayish-white pollinose, beard and mystax white, occipito-orbital bristles white. Thorax black, faintly grayish-brown pollinose, mid-dorsal stripe faint; dorsum sparsely covered with short, black hairs, which are longer apically. Scutellum with black hairs and bristles, some of which are white apically. Pleuræ faintly pollinose, covered not densely with moderate long white hairs. Abdomen black, first to third segments with black hairs, longer at sides, fourth segment with long white hairs intermixed with black hairs, which are directed outwardly; fifth segment white pollinose and with shorter white hairs, sixth and seventh segments densely white pollinose; apical margins of segments two to five grayish pollinose. Venter grayish-white pollinose, covered with long, white hairs. Hypopygium black, clothed with shorter white hairs. Wings pure hyaline. Legs entirely black, clothed with shorter and longer white hairs. Furcation of the third vein almost directly opposite the base of the second posterior cell, stump rather short.

Female. Total length 22 to 27 millimeters. Colored much as in the male, abdomen black, narrowly gray pollinose on the sides and posterior margin of each segment, hair of the abdomen largely white, but some black, especially on the dorsum. Oviduct rather long, longer than the last three abdominal segments.

Type: Male, in the Brooklyn Museum of Arts and Sciences, is labeled Beaver Creek Hills, Beaver County, Utah. Other specimens at hand from Reno, Nevada, New Mexico and California. The California specimens are at the Museum of Comparative Zoology at Cambridge, Mass., and are from the collections of Loew and Osten Sacken. Loew gave the manuscript name lencotrichus to the species.

The predominance of pure white bristles of the legs is a distinctive character and easily separates it from most related forms. The bristles of the feet especially practically all are white.

Williston's *aridus* is much like subpilosus in general appearance but the latter has a much longer oviduct. The color of the vestiture of the abdomen is more or less variable in subpilosus.

The **anomalus** Group.

Three species belong to the group with three submarginal cells normally. They are all rather light colored and inhabitants of more or less arid regions. Coquillett has proposed the genus *Efferia* for the reception of these species, but usually it is considered a synonym of *Erax*. The furcation of the third vein occurs about midway between the base of the second posterior cell and the anterior cross vein. Costa not dilated.

1. Bristles of the palpi, scutellum and upper part of the occiput, black, **anomalus** Bellardi
   Bristles of the mystax, palpi, upper part of the occiput and usually of the scutellum, pale 2
2. Male abdomen with white hairs parted at the middle and directed outward. **candidus** Coquillett
   Male abdomen gray pollinose and without white hair parted at the middle and directed outward ..... **pernicis** Coquillett

Erax anomalus Bell.

Male. Total length 18 to 26 millimeters. Mystax varying from white to pale yellowish, beard white, palpi sometimes clothed with white hair and sometimes with black, thorax with white and black hair and black bristles, scutellum with white pile on its disc and a row of black bristles on its margin. The color of hair and bristles appear to be somewhat variable, however; wings hyaline. Femora dark, usually black, anteriorly and reddish posteriorly, tibia reddish, darker near apex, tarsi darker than the tibiæ. Abdomen largely silvery pollinose, segments two to six with long silvery hair parted at the middle and directed outward. Hypopygium shown from side in Figure 10. Wing shown in Figure 5.

Female. Abdomen above with a prominent black triangle on each segment with its base on the anterior margin and its apex not quite reaching the posterior border, otherwise gray pollinose. Some variation in the extent of the black occurs however. Oviduct almost as long as abdominal segments five, six and seven.

Range: Kansas to Texas and Mexico and westward.

Erax candidus Coquillett.

Total length 15 to 30 millimeters. Body in both sexes white pollinose, mystax and beard silky white, palpi with white hair, femora, apexes of tibiæ, and tarsi black, basal three-fourths of each tibia sometimes pale yellow, sometimes darker. Legs everywhere with white hair and an occasional black bristle. Male abdominal segments two to four with white hair parted at middle and directed outward, segments six and seven without such hair. Hypopygium shown from the side in Figure 11.

Range: Kansas, New Mexico, Arizona and California.

Erax pernicis Coquillett.

Total length 15 to 20 millimeters. Known from candidus by being less distinctly white pollinose, the male is devoid of long hair on the abdomen. The species averages smaller and the hypopygium is different. See Figure 12.

Specimens from Arizona and California.

The **aestuans** Group.

The species of this group have been divided into two parts for the purpose of the present paper. So far only one species has been found to be common to both the North American continent and to the West Indies. This being the case the two faunas are separated and a key given for each in order to facilitate determination.

The species falling in the group are recognized at once by the peculiar posterior branch of the third vein which, instead of curving forward at its apex, as in other groups, curves backward and reaches the costa near or beyond the apex of the wing. The branching of the third vein occurs beyond the base of the second posterior cell. The following key is offered as an aid in separating the species of the North American Continent.

1. Legs entirely shining black....2
   At least the tibiae distinctly red....4
2. Wings hyaline, male costa normal....**slossonæ** n. sp.
   Wings distinctly pale brownish, more pronounced on apical half; male costa plainly expanded....3
3. Total length, 20 millimeters or over, hypopygium longer than abdominal segments five, six and seven....**loewii** Bellardi
   Total length not over 15 millimeters, hypopygium tumid....**mexicanus** n. sp.
4. Hypopygium from side view, most prominent apically on upper half, small species....5
   Hypopygium most prominent at middle apically, medium to large species....6
5. Mystax yellow....**aurimystaceus** n. sp.
   Mystax black with gray hairs intermixed....**belfragei** n. sp.
6. Femora red apically....**affinis** Bellardi
   Femora black....7
7. Costa more or less dilated in the male, usually large robust species. Mystax black, intermixed with white hairs....8
   Costa not at all dilated, medium sized slender species. Mystax with black bristles above and pale yellow hairs below. Three species difficult to separate. Refer to figures of hypopygiums....10
8. Hypopygium unusually large, conspicuously pilose below (Cuban species, one record from Florida), mystax with a few black bristles....**stylatus** Fabr.
   Hypopygium of normal size. Mystax composed mostly of black bristles....9
9. Total length 25 millimeters or more, the largest species of the aestuans group....**femoratus** Macquart
   Total length 23 millimeters or less, tibiae dark brown, general body color blacker than usual....**aestuans** Linn.
10. Hypopygium with a tuft of dense pile below at apex....**tabescens** Banks, n. sp.
    Hypopygium without such a tuft....11
11. Apical part of hypopygium narrowed and curved downward, with a tooth-like prominence above....**apicalis** Wiedemann
    Apical part of hypopygium nearly as wide as the preceding part, **kansensis** n. sp.

Erax belfragei n. sp.

Male. Total length 10 millimeters. Mystax largely black though with some gray intermixed; palpi with black pile, beard gray, thorax gray pollinose with the usual black markings, hair and bristles mostly black, although some gray intermixed on posterior part and on the scutellum. Wings slightly fumose, a little more intense toward the apex, costal border not dilated in the least, stump on anterior branch of the third vein not quite as long as the connecting vein, perhaps the length of this stump will be variable however. Femora entirely black, narrow apexes of tibiæ and entire tarsi black. Abdomen dark, largely gray pollinose, dorsum of segments two to four black before the narrow posterior gray borders, segments five, six and seven silvery; genitalia elongate, sides nearly parallel, widened somewhat on posterior third and notched at tip. Figure 21.

Female colored like the male, stump of anterior branch of the third vein fully as long as abdominal segments four to seven inclusive.

Type: Male and allotype bearing the label "Texas," Belfrage. In the U. S. National Museum.

Most closely related to *aurimystaceus* but the color and male genitalia are clearly distinctive.

Erax slossonæ n. sp.

Male. Total length 14 millimeters. Mystax prominent, mostly white, but with a number of black bristles in the upper part, palpi with black pile, beard white, dorsum of the mesothorax with long black hair and bristles, scutellum with white hairs on its disc and a few black bristles on its margin. Wings hyaline, very short, much shorter than the connecting vein; legs entirely shining black, clothed with white and black hair and black bristles. Abdominal segments two, three and four black before the narrow, gray pollinose, hind-margins, dorsally. Narrow posterior margin of four, all of five, six and seven silvery; genitalia shining black, with black hair, widened from the side gradually to middle, then narrowed gradually and with a rather large extension apically partly cut off by incisions above and below. See Figure 25.

Male type from Jacksonville, Florida, collected by Mrs. Anna T. Slosson and forwarded by C. W. Johnson.

Very distinct from other species of its group from Eastern United States on account of its entirely shining black legs. The male genitalia distinguish it readily.

Erax affinis Bellardi.

Total length 17 millimeters. Mystax black and white mixed, palpi with black and white hairs and bristles, beard white, thorax yellowish brown pollinose with the usual black markings; scutellum white pilose with black or white marginal bristles; legs variable to some extent, femora usually black on basal three-fourths and red at apex,

but nearly all red in some specimens, although all I have seen have at least a trace of black on the front side of each; tibiæ red, darker apically, tarsi dark red with black bristles. Wings yellowish, slightly more intense toward apex, male costa slightly dilated. Abdomen dark, gray pollinose on venter and sides. Male with segments six and seven silvery, genitalia shining black with an extension apically attached below and directed upward. See Figure 28.

Female colored like the male, except femora are more extensively red than in the other sex in some of the specimens studied.

The females taken in the same locality as the males, as well as other females before me, agree with Bellardi's description of *marginatus*. He described *affinis* from a male and *marginatus* from a female. It appears that they are sexes of the same species.

Specimens from Mexico and from Bonda, Columbia, S. A.

Erax kansensis n. sp.

Total length 17 millimeters. Mystax largely pale straw yellow, but with some black bristles intermixed, palpi clothed with black hair, beard nearly white, though with a tinge of straw color. Thorax above with black and white pile and some black bristles; wings hyaline, a tinge of brownish in the apical part of the marginal cell, costa not dilated, anterior branch of the third vein with only an indication of a stump; femora, apexes of tibiæ and entire tarsi black, basal three-fourths or more of tibiæ bright yellow; abdomen dark in ground color, largely thinly gray pollinose, seventh segment just slightly silvery. Male genitalia narrow; not long, narrowed suddenly and bearing at the tip an angular extension. See Figure 19.

Female colored like the male, genitalia rather wide and somewhat longer than abdominal segments five, six and seven.

Type: Male and allotype, from Clark County, Kansas, elevation 1962 feet. F. H. Snow. In the author's collection. Easily identified by the male genitalia. Most closely related to apicalis.

Erax aurimystaceus n. sp.

Length of male 13 millimeters. Mystax rather large, golden yellow, beard paler yellow. Thoracic dorsum with numerous rather long black hairs and some pale yellowish hairs intermixed on the posterior part where they are distinctly longer than on anterior part. Scutellum with numerous pale hairs on the disc and two black bristles apically. Wings uniformly very pale yellowish hyaline, femora entirely deep black, tibiæ bright yellow with extreme apexes black, tarsi darker, but mostly reddish, with numerous black bristles. Legs clothed with fine pale hairs and black bristles. Abdomen yellowish gray pollinose, segments two to five each with a large quadrate black spot above, segments six

and seven silvery. Hypopygium shining black with abundance of fine black hair; from side view notched at tip and quite different from other species of its group. Refer to Figure 22.

Holotype: Male from Clark County, Kansas, F. H. Snow. Several males and females from Clark, Ellis, Grove and Ness Counties, Kansas, mostly taken in July.

The female differs from the male only in sexual characters. The oviduct is distinctly shorter and stouter than in aestuans and apicalis, being only about as long as the last three abdominal segments.

The species is entirely distinct and easily recognized by its small size, yellow mystax and male and female genitalia. The bristles at the apex of the scutellum are subject to slight variation in number and in some specimens are golden yellow instead of black.

Erax mexicanus n. sp.

Male. Total length 12 millimeters. Mystax black above, pale yellow below, palpi with black bristles, beard pale yellowish, wings nearly uniform brownish, costal margin very slightly dilated, stump of anterior branch of the third vein much shorter than the connecting vein; legs black in all their parts. Abdomen black with yellow hairs, segments five, six and seven silvery, venter of last abdominal produced backward the length of more than two abdominal segments and with several black hairs at the tip. Genitalia black, shining, tumid, suddenly narrowed before the apex, produced into a distinct tubercle. See Figure 27.

Female colored like the male; stump of the anterior branch of the third vein a little longer than in the male, but not much longer than the basal section. Genitalia somewhat longer than segments five, six and seven.

Male type and allotype from Tapachula, Chiapas, collected by D. H. Crawford. Three other males from the same locality. One male is somewhat larger than the type and has only abdominal segments six and seven silvery.

The small size, black legs and peculiar male genitalia serve to distinguish the species.

Erax femoratus Macquart.

Total length, male and female, 26 to 30 millimeters. Mystax largely black, but with white hairs intermixed, beard pale, palpi black hairy, occipito-orbital bristles black; mesothoracic dorsum before with very short black hair, several strong black bristles above the roots of the wings and before the scutellum; scutellum with fine white hairs

on the disc and several strong black bristles on its margin, femora black, tibiæ and tarsi dark red, apices of tibiæ and tarsi darker in some specimens than others; wings hyaline, male costa slightly dilated. Male abdomen, first four segments gray on the sides and narrow hind margin; segments five, six and seven silvery, hypopygium black and largely black hairy. Female abdomen with each segment gray on sides and narrow posterior border, oviduct nearly as long as the last four abdominal segments.

From Slidell, Louisiana, and from Florida.

Much like *æstuans* and there is some doubt in regard to its distinctness from that species, but the large size and robust form give it quite a different appearance. The specimens I collected at Slidell, Louisiana, were taken from the trunks of trees.

Erax aestuans Linne.

Variable in size. Usually ranging from 18 to 22 millimeters, but specimens as small as 14 millimeters and others as large as 28 are taken occasionally, especially females if measurement is taken to the tip of the oviduct.

The body usually is more hairy than in other species of its group. Mystax composed of black bristles and gray hairs, dorsum of the thorax with numerous black hairs and bristles on the posterior part, scutellum with an apical row from six to ten black bristles, wings slightly tinged with brownish, legs black with bases of tibia rather dark brown, abdomen black with a narrow gray posterior border to each segment. The male has from two to four apical abdominal segments silvery. Figure 17 shows the form of hypopygium from lateral view. The oviduct is slender, nearly as long as the last four abdominal segments and usually turned to one side or the other in dry specimens. Figure 4.

Habitat: Widely distributed over north-eastern North America, ranging to Florida, New Mexico and Wyoming. A very abundant species over much of its range.

The rather pronounced hairiness of the body, especially the posterior part of the dorsum of the thorax where the hairs are unusually long and plentiful, the row of bristles on the scutellum, the brown and not yellow tibiæ and form of hypopygium rather easily distinguishes this species from others of its group.

Variation in size and the extent of the silvery color of the male abdomen has given an excuse for a number of synonyms of the species. Thus macrolabis is used for the specimens having four segments silvery. I have observed this character often and find it appearing so irregularly that it can hardly be

considered specific. Wiedemann's *niger* appears to be a rather large female of *aestuans*. Some Georgia specimens before me measure 26 millimeters and agree with the description of *niger*.

Erax apicalis Wiedemann.

Size variable. Males and females before me are from 14 to 22 millimeters in total length; average specimens are about 17 millimeters long. Mystax white with only a few black bristles above, beard silky white. Dorsum of the thorax with very short black pile anteriorly and a sparse arrangement of longer white hairs and black bristles posteriorly, scutellum with rather long white hair on its disc and two black bristles on its apical margin. Wings hyaline, slightly infurcated near the apex. Femora, tarsi and apexes of tibiæ black, remainder of tibiæ bright yellow. Abdomen gray pollinose with a large quadrate black spot on the dorsum of each segment. Male with the last two abdominal segments silvery but often the anterior one of the two is more or less encroached upon by a black spot. Female with oviduct shining black and near the length of the last four abdominal segments. Lateral view of the hypopygium shown in Figure 18.

The species is southern in range. Specimens from Decatur County, Georgia, collected by Bradley, and from southern Pines, North Carolina, by Manee.

The trim appearance of the species is notable. The hairs of all parts of the body are shorter and sparser than in *æstuans*; normally there are only two black bristles at the apex of the scutellum, although some variation may be encountered, and the tibiæ are bright yellow instead of brown.

Wiedemann ascribes the species to North America, but it is presumed his specimen was from the southern part of the country for other species described near it are from Savannah, Georgia. Prof. Comstock is the only recent writer to mention the observation of sepcimens when he records their preying upon larvæ of *Aletia argillocea* in Alabama.

Macquart described *vicinus* from Galveston, Texas, and the description suggests that it is the same as *apicalis*.

Erax loewii Bellardi.

Total length 19 millimeters. Mystax black and pale intermixed; beard gray with just a tinge of yellowish, palpi with black hair. Thorax largely gray pollinose with the usual black markings, wings nearly hyaline basally, apical half yellowish, male costa a little dilated, stump of the anterior branch of the third vein short. Legs entirely black, posterior of tibia and tarsal segments golden pilose. Male abdomen

dark, segment six on posterior corners and hind margin and segment seven silvery above; genitalia black, regular, with a small rounded prominence apically. Figure 20.

Female colored like the male, stump of the anterior branch of the third vein rather long, longer than the basal section, genitalia somewhat longer than abdominal segments five, six and seven.

Specimens from Mexico, Tapachula, Chiapas, Cordoba, Morales, Guatemala, and from Onaca, Columbia.

There are only a few species of *Erax* with entirely black legs, so this one is rather easily identified. Williston's clear description of *dolichogaster* lends a feeling of satisfaction to the student who has it for determination and Bellardi's figure of lœwii is very good. That the two names refer to the same species is quite evident. Neither Williston or Osten Sacken recognized *lœwii* in Biologia Centrali Americana.

Erax tabescens Banks n. sp.

Male. Total length 18 millimeters. Similar to Erax aestuans in having the hind part of third vein ending beyond wing tip, and the fork beyond the base of the second posterior cell. The mystax is black, with some white hairs, palpi black haired, head and thorax also with black hairs. The venter is gray with dark median streaks, the sides and hind margins of the segments above pale, the lateral margin of the sixth segment broadly silvery, the seventh wholly silvery. The abdomen is more slender than in Erax aestuans. The hypopygium is rather smaller, but noticeably more slender than in Erax aestauns and is clothed with black hairs; the legs are black, the tibia, except tip, pale yellowish, the hair of femora and tibiæ is almost wholly white (mostly black in Erax aestuans). See Figures 16 and 26.

From Florida (Loew collection and his manuscript name.)

It appears that only one species of the genus *Erax* outside of the *æstuans* group has been reported from the West Indies. Both Bigot and Williston report *rufibarbis* from Cuba, but it seems that this species is only occasionally taken. The species of these islands are much alike in general appearance and some of them are confused with others in literature, although not much has been written aside from the original descriptions.

What is known now as *æstuans* Linne has a large number of synonyms as may be seen by reference to the list of species on a previous page, and besides it has been customary to identify related species with this one because of the close relationship of members in the group. Study of much material from various parts of the country seems to throw some doubt on the cor-

rectness of the extensive distribution of *æstuans* which is given as occurring from New England to Guiana, including records for the West Indies.

Seven species are recognized in the material at hand from the West Indies, mainly based on a study of male genitalia, and none of them are regarded as the common *æstuans* Linne of the Eastern United States. The following key will aid in separating them.

1. Mystax pale, scutellum with white pile and bristles.....2
   Mystax in large part black, scutellum with black bristles.....4
2. Mystax straw yellow.....**nigritarsis** n. sp.
   Mystax white.....3
3. Hypopygium long and narrow.....**portoricensis** n. sp.
   Hypopygium short and tumid.....**rufitibia** Macq.
4. Male costa distinctly thickened and dilated beyond the tip of the auxiliary vein, wings distinctly reddish.....5
   Male costa not thickened and dilated. wings nearly hyaline.....6
5. Hypopygium much enlarged, rather large robust species.....**stylatus** Fabr.
   Hypopygium small, species 16 millimeters in total length **nigrimystaceus** Macq.
6. Hypopygium short and tumid, shining black all over.....**rufitibia** Macq.
   Hypopygium elongate.....7
7. Large species, hypopygium much elongate.....**fulvibarbis** Macq.
   Medium sized species, hypopygium only slightly elongate....**haloesus** W. K.

Erax stylatus Fabricius.

Total length, male 20 to 26 millimeters, female, 18 to 28 millimeters. Mystax composed of numerous black bristles intermixed with fine white hair, beard white, palpi with white hairs, but mixed in is an occasional black one, in some specimens more than others. Femora entirely black, tibiæ yellow, each very narrowly black at apex, tibiæ somewhat darker than the tibiæ and with numerous black bristles; wings distinctly brown.

Male genitalia large, fully as long as abdominal segments five, six and seven. See Figure 32. Costal border of the wing distinctly dilated beyond the tip of the auxiliary vein. Usually no stump on anterior branch of the third vein, although in some cases there is a very short one.

Female genitalia shining black, about as long as segments four to seven, wings almost hyaline, costal border of wing not dilated, anterior branch of the third vein with a distinct stump.

Specimens from several places in Cuba, from Porto Rico, and one male from extreme southern Florida, indicating a wide range. The Florida specimen is peculiar in having the whole abdomen from the apex of the second segment to the genitalia silvery, but I can find no other differences.

Although *stylatus* has not been recognized by most authors, Wiedmann's figure should help in its determination. With more

than thirty very well preserved specimens for study the literature has been consulted fully and the above synonymy worked out. I have no doubt the males and females before me are the sexes of the same species. They seem to combine with characters mentioned by Fabricius, Macquart and Walker who, as a usual thing, seem to have had each a single specimen in hand. Thus the descriptions of *stylatus* and *invarius* were taken from females, while those of *caudex* and *haitensis* were of males. The name *caudex*, as Walker indicates, was used because of the "very large" genitalia. Macquart's figure of the wing of *haitensis* shows the distinctly dilated costal border which is shown in the males before me. The large size Walker gives for *invarious*, together with other characters, is good proof of its synonymy with *stylatus*. These statements are emphasized when it is pointed out that among no less than eight West Indian species this is the only one that combines the dilated costa and large male genitalia, while only one other has a slightly dilated costa and one a somewhat enlarged hypopygium. Most likely Van der Wulp was in error when he reported *stylatus* from Wisconsin. The descriptions given by all the author's mentioned in this connection are more or less deficient and one could easily apply them to several species of the genus.

Erax rufitibia Macquart.

Total length 18 millimeters. Rather dark species, thorax and abdomen largely gray pollinose. Mystax black with a few white hairs intermixed, beard white, palpi black haired, hairs and bristles of the thorax all black; wing slightly fumose, no costal dilation in the male, anterior branch of the third vein with a stump which is about equal in length to the basal section. Femora black, tibiæ and tarsi almost wholly red. Sixth and seventh abdominal segments silvery in the male, genitalia of male short, somewhat tumid. Figure 30.

Females agrees with the male except in sexual characteristics.

From Bahamas and Cuba.

Erax portoricensis n. sp.

Total length 20 millimeters. Mystax, hairs of the palpi and beard white, an occasional black hair in the mystax, dorsum of the thorax largely rusty brown pollinose, wings pale brown, nearly hyaline, costal margin not dilated, stump of the anterior branch of the third vein equal in length to the basal section, femora and tips of tibiæ black, basal three-fourths of tibiæ yellowish brown, tarsi dark reddish brown, nearly black, with abundance of black bristles. Abdomen darker

dorsally, segments six and seven silvery. Male genitalia elongate, rather narrow, apical part narrowed, then rather suddenly widened, angular at apex. See Figure 24.

Female colored like the male, but tibiæ more plainly reddish brown, genitalia hardly as long as segments four to seven inclusive.

Type: Male from Ensenada, Porto Rico, June 14 to 19, 1915, and allotype from the same place at the same date, property of American Museum of Natural History.

The male is easily recognized by its peculiar genitalia.

Erax nigritarsis n. sp.

Total length 18 millimeters. Mystax, beard and hairs of the palpi all light colored. Thorax in large part gray pollinose, mid-dorsal space and some spots on either side of mesothorax black on account of the very sparse pollen with which they are covered. Wing hyaline, only a tinge of yellowish, costal border only very slightly dilated, so slight that it is hardly evident, stump of the anterior branch of the third vein very short, much shorter than the basal section; femora black, tibiæ yellow to near the apex, tips of tibiæ and tarsi intensely black, ventral side of metatarsal segments and some other segments golden pilose. Abdomen gray pollinose, darkest dorsally, segments six and seven silvery, genitalia short, somewhat tumid from side view, narrowed from the middle towards apex where it is truncate. See Figure 29.

Female colored like the male in all respects, genitalia shining black, approximately as long as abdominal segments four to seven inclusive.

Type: Male and allotype from Holguin, Cuba, December 19, 1904, collected by H. S. Parish. In the author's collection, a male and four females from various Cuban localities in American Museum of Natural History.

The pale mystax, tibial hairs, beard and black tarsi, with the structural characters described are distinctive for the species.

Erax fulvibarbis Macquart.

Total length 25 millimeters. A dark appearing species. Much of the thorax and parts of the head and abdomen rusty brown pollinose; mystax composed of numerous black bristles with a tuft of rather coarse white hairs below, beard white, palpi black haired; femora all black, each femur, especially the posterior, has a longitudinal row of six or seven rather strong black bristles on the outer side, beginning well towards the base and extending to near the apex. Most species have not more than four of these bristles. Tibiæ light brown with the apex of each distinctly black, tibiæ black; wings tinged with brownish, front costal border not dilated in the least, anterior branch of the third vein with a very short stump. Abdomen dark, segments two and three each, with a silvery triangular marking on each side posteriorly, segments six and seven silvery dorsally, lateral view of male genitalia shown in Figure 23.

A male specimen from San Domingo. This species agrees exceedingly well with Macquart's description of *fulvibarbis* and comes from the type locality. The row of six or more bristles on outside of hind femur easily suggests the species.

Erax haloesus Walker.

Total length 18 millimeters. Mystax white with numerous heavy black bristles, beard white, scutellum with white hairs on its disc and about four rather slender black bristles on its margin; tibiæ bright reddish yellow, except distally, tips of tibiæ and tarsi black, although the latter may be partly dark reddish brown, costa not thickened, wings dilute yellowish hyaline. See Figure 36. Hypopygium elongate, distinctly red at tip.

A male specimen from Jamaica furnished by C. W. Johnson by whom it was identified. The hypopygium enables this species to be determined readily.

Erax nigrimystaceus Macquart.

Total length 17 millimeters. Mystax largely black with pale yellowish hairs intermixed, palpi with black hairs, beard straw yellow, thorax dark, gray pollinose, bristles and hairs black, many black upright hairs on the scutellum, wings distinctly yellowish, a little more intensely so toward apex, costal border plainly, though not strikingly, dilated, stump of the anterior branch of the third vein very short, not half the length of the connecting vein; entire femora, apexes of tibiæ and tarsi clear black, basal three-fourths or more of tibiæ brown. Abdomen dark, partially gray pollinose, segments six and seven silvery. Hypopygium black, not tumid, gradually widened from the base to beyond middle then slightly narrowed and truncate at apex with two minute emarginations, one dorsal and the other ventral. See Figure 31.

Male from Dominica, West Indies, November, 1903. Furnished by Chas. W. Johnson.

The **carinatus** Group.

In Western United States and extending into Mexico and Central America there are several species of the genus ***Erax*** that are distinct from the others on account of the following characters:

The dorsum of the mesothorax is more convex than usual, with a distinct crest of erect hairs on the middle of the dorsum, beginning just behind the head and extending back to beyond half the distance to the scutellum. Branching of the third vein beyond the base of the second posterior cell; stump rudimentary or altogether absent in the male, present and somewhat variable in length in the female; costa in the male always thickened and expanded but much more evident in some

species than others. Ten species of this group are at hand and at least one other is characterized sufficiently so that it should be determined easily when specimens are procured.

1. Vestiture of the scutellum, aside from the black marginal bristles, black or yellow....2
   Vestiture of the scutellum, aside from the black marginal bristles, white....4
2. Vestiture of the scutellum black....**jubatus** Williston
   Vestiture of the scutellum composed of black bristles on the margin and yellow hair on the disc....3
3. Male with the last four abdominal segments silvery....**concinnatus** Williston
   Male with the last two abdominal segments silvery....**carinatus** Bellardi
4. Femora red apically and sometimes posteriorly....5
   Femora all black....6
5. Second to fifth abdominal segments of the male with long white hair parted at the middle and directed outward, abdomen wholly gray pollinose. **unicolor** Bellardi
   Abdomen without hair parted at the middle and directed outward, basal segments of the abdomen black....**parvulus** Bellardi
6. Robust species, mane-like crest of the anterior part of the mesothorax, especially thick and long, male costa very prominently thickened,. **subcupreus** Schaeffer
   Slender species, mane-like crest normal, male costa only slightly thickened....7
7. Male abdomen with only the last two or three segments entirely silvery, without prominent white hair parted at the middle and directed outward; other segments with black markings....**latrunculus** Williston
   Male abdomen with at least four or five segments silvery, and with long white hair parted at the middle and directed outward....8
8. Hypopygium divided apically with both parts of nearly equal length. **cressoni** n. sp.
   Hypopygium emarginate apically with the upper part much shorter than the lower....**costalis** Williston

Erax carinatus Bellardi.

Total length 18 millimeters. Body yellowish gray pollinose, hairs and bristles black and pale yellow. Mystax yellow with a few black bristles, beard paler yellow than the mystax, ocellar bristles black, hair on scutellum and in front of it straw yellow, a few black bristles on the scutellar margin; femora black, tibiæ and tarsi largely red, bristles black. Abdomen with short, sparse, yellowish hair, segments six and seven silvery. See Figure 58.

Male from Guerrero, Mexico.

Erax concinnatus Williston.

Total length 16 millimeters. Mystax and beard pale yellow, the former mixed with black bristles, palpi black haired. Disc of scutellum and rear of mesothorax yellow haired, margin of scutellum with a few black bristles. Femora entirely black, tibiæ and tarsi yellow, apex of tibia and each tarsus darker. Wings yellowish hyaline. Abdominal segment one and two and base of three black dorsally, sides of first three segments, apex of three and all of four to seven inclusive, silvery, hypopygium black, of medium size. See Figure 57.

Male from Guerrero, Mexico.

Erax parvulus Bellardi.

Total length 13 to 15 millimeters. Mystax and beard white, the former with black bristles intermixed. Disc of scutellum and rear of mesothorax white haired. Margin of scutellum with a few black bristles. Wings hyaline. Femora, except at extreme apex, black, apexes of femora, tibia and tarsi red. Male, first three abdominal segments dorsally black, narrow posterior margins of two and three and all of four, five, six and seven silvery. Hypopygium black. See Figure 55. Female abdomen black, narrow sides and hind margin of each segment gray pollinose, oviduct slightly longer than the last three abdominal segments.

Male and female from Guerrero, Mexico.

Erax unicolor Bellardi.

Total length 16 to 19 millimeters. Mystax pale yellow with a few black bristles, beard pale yellow, palpi black haired, mesothorax with black hairs and bristles, scutellum with white hairs and a few black bristles on its margin, femora black to near the tips, apexes of femora and tibiæ and tarsi red. Abdominal segment one and base of two gray, apex of two, and whole of segments three to seven, inclusive, silvery; segments two, three, four and five with long white hair parted at the middle and directed outward. Hypopygium black, emarginate at the tip. See Figure 60.

Female colored much as in the male, abdominal segments two to seven each with a dark triangle dorsally, oviduct about as long as the last three abdominal segments.

A male and female from Amatitlan, Guatemala, and five males and females from Tehauntepec, Mexico, (Sumichrast).

Erax latrunculus Williston.

Total length 15 to 18 millimeters. Mystax white with a very few black bristles, beard white, rear of the mesothorax and disc of the scutellum with white hair, margin of the scutellum with several black bristles, femora all black, tibiæ and tarsi red. Male, abdominal segments one to five each with a black spot above, large on segments two, three and four, small on five. Sides and hind margin of two to five inclusive and all of six and seven silvery. In one specimen six is all silvery, lacking the dorsal black spot. Hypopygium shining black, mostly with pale hairs. See Figure 56.

Female, abdominal segments one to seven inclusive each with a black spot above, sides and hind margin of each segment densely gray pollinose. Oviduct somewhat shorter than the last three abdominal segments combined.

Male and female from Arizona. This description is taken from specimens from Cornell University. Professor Bradley

considers them as belonging to the material which Williston had when he wrote the original description although they are not marked as types.

Erax jubatus Williston.

Total length 18 to 23 millimeters. A large, black, robust species, plainly the largest of the group. Mystax composed of numerous long bristly hairs which are mixed white and black in about equal numbers, beard silky white, palpi black haired, hairs and bristles of the thorax largely black, numerous long black bristly hairs on the scutellum and in front of it, although in some specimens white ones are intermixed. Femora black, tibiæ and tarsi dark red. Abdomen largely black, narrow posterior margin of the segments gray. Male, abdominal segments six and seven silvery, hypopygium noticeably large. See Figures 3 and 54. Costal margin of the wing prominently expanded and there may be a very short stump on the anterior branch of the third vein.

Female, usually a distinct stump on the anterior branch of the third vein; oviduct somewhat longer than the last three abdominal segments.

Forty specimens of both sexes from Northern Mexico, Arizona, New Mexico and Colorado.

A study of the variations exhibited in the specimens at hand suggest strongly that *prolificus* Osten Sacken, is a synonym of *jubatus*. The type locality for *jubatus* is New Mexico and that of *prolificus* is Northern Sonora, Mexico. Specimens vary much in some particulars, many have white hairs on the scutellum and before it, the bristles of the body are mostly black, but yellow and brownish ones occur, the fifth abdominal segment of the male is almost wholly black, with a rounded black spot, or entirely silvery.

The large size, generally dark color, and enlarged hypopygium suggest the species. However, there is much difference between the largest and smallest specimens.

Erax subcupreus Schaeffer.

Total length, male and female, 15 to 20 millimeters. Larger and more robust than costalis. Mystax rather long and dense, composed of black and white bristles and hairs in nearly equal proportion. Mane-like crest of hairs on the middle of the dorsum of the thorax conspicuous, black and reaching well beyond the transverse suture where it merges into a widened area of black and white hairs and bristles which reaches to the scutellum. Scutellum densely white haired and with several black marginal bristles, wings hyaline, femora black, tibiæ and tarsi very dark reddish. Male abdomen quite densely haired, first five or

six segments with long white hair parted at the middle and directed outward. Hypopygium black with black hair. See Figure 52.

Female abdominal segments all black above, sides and narrow hind margin of each gray pollinose, oviduct about as long as the last four abdominal segments. Fresh specimens have the body more or less metallic, which accounts for Schaeffer's name.

Specimens from Montana, Colorado, New Mexico, Arizona and Nevada.

The robust form and white-haired scutellum are characteristic for the species.

Erax cressoni n. sp.

Male. Total length 14 millimeters. Mystax and beard white, palpi black haired, mane-like row of hairs on the middle of the mesothoracic dorsum black and composed of numerous short hairs and an occasional long one, space in front of the scutellum with scattered black bristles and short white hairs. Scutellum with numerous short white hairs on the disc and four long dark bristles on the margin; femora black, tibiæ and tarsi red; wings hyaline, branching of the third vein far beyond the base of the second posterior cell, anterior branch with scarcely a suggestion of a stump. Abdomen, first segment white haired, second to fifth segments with white hair parted at the middle and directed outward, hair shorter on the fifth segment than on the others, first segment, anterior part of second and a small triangle anteriorly on dorsum of third showing dark from above, otherwise abdominal segments silvery white. Hypopygium dark, pale hairy, superior part notched at apex, part above notch narrow, but of same length as part below. See Figure 50.

Female. Length 14 millimeters, like the male in most respects; anterior branch of the third vein with a stump about equal in length to the basal section, each abdominal segment with a triangular spot which is not as densely pollinose as the other parts, oviduct shining black, about as long as the last three abdominal segments.

Type: Male and allotype from Alamogordo, New Mexico, in the collection of the Academy of Natural Sciences of Philadelphia; other specimens from El Paso, Texas.

Named for E. T. Cresson, Jr., who sent me the specimens.

Erax costalis Williston.

Total length, male and female, 14 to 16 millimeters. Mystax white with some black bristles intermixed, scutellum with abundance of white hair and about four black marginal bristles, wings hyaline, femora black, tibiæ and tarsi mostly dark red. Male, abdomen with segments two, three and four with long white hair parted at the middle and directed outward, first three segments largely black dorsally, apex of three and all of segments four to seven inclusive silvery, hypo-

pygium black with white hair. See Figure 53. Female, abdomen with each segment marked with black dorsally, sides and posterior margin of each segment white pollinose, oviduct somewhat longer than the last three abdominal segments.

Specimens from Montana, Wyoming and Colorado.

There is some doubt as to the proper identification of *costalis*, but the information available indicates that this species is the one for which Williston used the name in his key, Trans. Am. Ent. Soc., XII, 64. No description was ever wtriten, and Aldrich did not give it in his catalogue.

The **tuberculatus** Group.

The males of this group are at once known by the presence of a tooth-like prominence on the venter of each of abdominal segments four, five and six, and costa entirely normal. Branching of the third vein distinctly beyond the base of the second posterior cell. The species are slender and of rather small size.

1. Hypopygium and ventral tooth-like process of the abdomen red, **spiniventris** n. sp.
   Hypopygium and ventral tooth-like processes black..... 2
2. Ventral tooth-like processes of the abdomen all acute at apex, **tuberculatus** Coquillett
   First two ventral tooth-like processes knobbed at the apex....**productus** n. sp.

Erax tuberculatus Coquillett.

Total length 15 to 17 millimeters. Body gray pollinose and white hairy, ocellar bristles and some bristles in lower part of mystax black, palpi black hairy; femora, apices of tibia and tarsi black, tibia otherwise red. Male with venter of abdominal segments four, five and six each with an acute, black, tooth-like process produced downward. The presence of these ventral spines will put the male into its group at once, wings hyaline, branching of the third vein distinctly beyond the base of the second posterior cell, stump usually shorter than the basal section.

There is no very good way to characterize the females, but the small size and the forking of the third vein distinctly beyond the base of the second posterior cell are suggestive of the group. The oviduct is only slightly longer than abdominal segments six and seven in tuberculatus, but longer in other species of its group.

The type is in the United States National Museum. Other specimens from Davis Mountains, Texas (F. M. Gaige), and from West Fork, Texas (J. E. Scherer), taken in June.

Erax spiniventris n. sp.

Male. Total length 12 millimeters. Vestiture of the body largely white, ocellar bristles black, bristles of the legs largely white, but now and then a black one is intermixed; tibiæ, except the extreme apex of

each red, otherwise legs black, wings hyaline, branching of the third vein beyond the base of the second posterior cell, stump very short. Abdomen largely gray pollinose, venter of segment four and five each with a distinct red prominence, narrowed basally and enlarged apically, with the main part of the enlargement directed posteriorly; sixth segment with a narrow pronounced red tooth-like appendage pointing almost directly downward and acute at apex. Hypopygium red in color, from side view, widest at basal third and gradually narrowed toward apex, where it is almost truncate.

Type: Male from Santa Rita Mountains, Arizona, 5,000 to 8,000 feet, July, (F. H. Snow). In the author's collection.

The form and color of the hypopygium and ventral abdominal prominences easily characterize the male of the species.

Erax productus n. sp.

Male. Total length 16 millimeters. Body largely white pilose and gray pollinose, palpi black hairy, basal two-thirds of tibiæ red, legs otherwise black, and with black bristles; wings pale yellowish, hyaline, branching of the third vein beyond the base of the second posterior cell, stump very short. Abdominal segments four and five ventrally, each with a short blunt prominence, segment six with a large acute prominence directed downward. Hypopygium, from side view, of nearly uniform width, rather long, apically each outer corner prominently produced.

Female. Of similar size and color as the male; oviduct fully as long as the last three abdominal segments.

Type: Male and allotype from Flinn Springs, Lakeside, Cal., August 9, 1917. E. G. Holt, collector. Collection of the author. Other specimens from Spring Valley and Poway, August 10 and 14, by the same collector.

This species is of nearly the same size as *tuberculatus*, but the ventral abdominal appendages and hypopygium are quite different and easily characterize the male.

The **rufibarbis** Group.

The females of this group differ from all other species by having the last segment of the oviduct divided at the tip. This character is easily seen from dorsal view. The mesothorax and scutellum is unusually bristly, the third vein branches beyond the middle of the distance between the base of the second posterior cell and the small cross vein. The male has abdominal segments six and seven silvery. The oviduct is rather short and rigid and the hypopygium is rather small. Mystax without or with very few black bristles.

1. Mystax yellow, body and wings dark colored.....**rufibarbis** Macquart
   Mystax nearly white, body gray pollinose, wings hyaline....**bicaudatus** n. sp.

Erax rufibarbis Macquart.

Male. Total length 16 to 30 millimeters. Mystax and beard distinct reddish yellow, palpi black and clothed with black hair, color of the body dark brown pollinose, thorax with black hair and bristles, scutellum with black hairs on the disc and numerous black bristles, irregularly arranged, on the margin. Legs mostly black with numerous dark and reddish hairs and black bristles, tibia dark reddish on basal half or more, wings brown, many specimens have the margins of the veins more intensely colored, costa not dilated, branching of the third vein nearly opposite the base of the second posterior cell. Abdominal segments six and seven silvery, hypopygium shining black.

Female colored like the male and just as variable in size; oviduct shining black, about as long as abdominal segments six and seven, abruptly narrowed before the apex, furcate from dorsal view.

The species has a wide range in Eastern North America, including the West Indies. Normally colored specimens are at hand from as far west as the Dakotas and central Texas. Farther west specimens are lighter in color and indications are that *rufibarbis* more or less gradually approaches *bicaudatus* in that region.

A study of venation in *Erax* reveals some variations which are useful in grouping species. There is a small group of species that has three submarginal cells normally and there are some species outside this group where now and then a specimen has three submarginal cells in only one or in both wings. Thus *anomalus*, *candidus* and *pernicis* may be characterized as a group by the presence of the extra cell while *rufibarbis* and *bicaudatus* have an occasional specimen only with this character. An estimate of material at hand indicates that about two per cent of these species are abnormal in this respect. The type of *ravus* in the U. S. National Museum is an abnormal *rufibarbis* and from much material studied, results indicate that scarcely any doubt exists that *completus* is the same, thus adding two more to the long list of synonyms of our common *Erax*.

Macquart's figure of the wing of his *completus* shows the forking on the third vein opposite the cross-vein at the base of the second posterior cell, and not midway between the latter cross-vein, and the small cross-vein as is the case in all the species of *Erax* having three submarginal cells normally. This fact and his statement regarding the male "*Abdomine segmentis duobus apicalibus niveis*," which is distinctly so in regard to *rufibarbis* but not of any of the anomalus group, are the con-

vincing facts in support of the conclusion reached in regard to *completus*.

There is some doubt about *Asilus dascyllus* of Walker but some things in the description suggests *rufibarbis* and the great amount of collecting in Massachusetts, the type locality, up to the present has not revealed any other possibilities, so have used my best judgment. Walker himself transferred *dascyllus* to *Erax* later when he had a better understanding of the genus.

Van der Wulp's figure of the female of his *Proctocanthus virginianus* is an excellent outline of *Erax rufibarbis*. The tip of the oviduct is quite suggestive and it is not right for *Proctacanthus* at all. The size is right and the description is not bad.

Erax bicaudatus n. sp.

Male. Total length 24 millimeters. Mystax and beard white, palpi black with black hair. Thorax largely with white hairs and bristles. Mid-dorsum before the suture with a row of rather long black hairs, which is suggestive of the mane in the jubatus group, although quite different, for it is made up of numerous hairs somewhat sparsely placed over a rather wide strip and does not form a dense comb as in the group mentioned. Well preserved specimens show it to best advantage. Scutellum with black hair on the disc and numerous white bristles placed irregularly on the margin. Wings hyaline, costa not dilated, branching of third vein a little before the base of the second posterior cell, stump of the anterior branch somewhat longer than the basal section. Legs largely black with numerous white hairs and black bristles, tibia reddish on basal third, especially the anterior and middle pairs. Abdomen dark, partly gray pollinose with much white hair and dorsally with some short black hair, segments six and seven silvery. Hypopygium medium sized, black, reddish in part, clothed mostly with white hair.

Female. Total length 25 millimeters. Colored like the male and differing only in sexual characters, oviduct about as long as abdominal segments six and seven, viewed from side narrowed abruptly before apex with a backward projecting point which from dorsal view is seen to be furcate.

Male type from Montclair, Colorado, July 30, 1898, and allotype from Morrison, Colorado, May 20, 1898. Both localities are near Denver.

Numerous other specimens of both sexes from a wide range, varying in size from 17 to 31 millimeters, and slightly in color, some specimens appearing much blacker than others.

The structure of the oviduct will separate the female from all species of its genus except *rufibarbis*, of which *bicaudatus*

appears to be the western representative. Over much of its range the species is very differently colored from *rufibarbis*, but the two approach each other in some localities. An occasional specimen has three submarginal cells either in one or both wings. The furcation of the third vein averages slightly further forward in *bicaudatus* than in *rufibarbis*, but this is variable within limits in both species. Specimens have been sent in under no less than half a dozen different specific names.

The **stramineus** Group.

One of the largest groups of the genus *Erax* is characterized by having the furcation of the third vein distinctly anterior to the base of the second posterior cell. In most all the species the mesothorax has many bristles posteriorly and the scutellum has many bristles on its margin and often numerous long hairs on its disc. Practically all the species are western or southern in distribution.

1. Furcation of the third vein at or before the middle of the distance between the base of the second posterior cell and the small cross vein.....2
   Furcation of the third vein distinctly beyond the middle of the distance between the base of the second posterior cell and the small cross-vein....18
2. Male abdomen without long hair parted at middle and directed outward on one or more segments.....3
   Male abdomen with long hair parted at the middle and directed outward on one or more segments.....5
3. Hypopygium from side view plainly divided at tip, oviduct conical, **interruptus** Macquart
   Hypopygium from side view not divided.....4
4. Hypopygium from side view narrowest at apex, tibiae basally bright reddish yellow.....**texanus** Banks, n. sp.
   Hypopygium from side view not narrowed at apex, tibiae basally dark reddish brown.....**californicus** Shaeffer
5. Mystax yellow.....6
   Mystax not yellow.....11
6. Tibiae at least largely red.....7
   Legs black.....9
7. Male third abdominal segment only with long white hair parted at the middle and directed outward.....**aurivestitus** n. sp.
   Male abdomen with at least four segments with long white hair parted at the middle and directed outward.....8
8. Abdomen white haired to base. Hypopygium with a rather conspicuous tuft of hair inferiorly at apex.....**canus** Hine
   Abdomen, especially the male, conspicuously darker on first and second segments than on the following ones, no tuft of hairs at apex of Hypopygium, **dubius** Williston
9. Body conspicuously dark colored, male with abdominal segments four, five and six only, white haired.....**splendens** Williston
   Body largely yellowish gray pollinose, male with abdominal segments three to seven inclusive white haired.....10
10. Usually not to exceed 18 millimeters in total length.....**stramineus** Willis.
    Specimens 20 millimeters or over in length.....**rapax** Osten Sacken
11. Mystax composed of black and white bristles and hairs intermixed.....12
    Mystax wholly pale.....13

12. Hypopygium from dorsal view conspicuously widened at apex..**inflatus** Hine
Hypopygium not widened.....**eximius** Bellardi
13. Bristles and hair of body and legs largely pale. Hypopygium from dorsal view distinctly widened at apex.....**varipes** Williston
Bristles of the legs largely black. Hypopygium not widened apically.....14
14. Hypopygium with a rather conspicuous tuft of hair below at apex, furcation of the third vein very near the middle of the distance between base of second posterior cell and small cross vein.....**canus** Hine
Hypopygium without conspicuous tuft of hair apically, furcation of the third vein plainly before the middle of the distance between the base of the second posterior cell and the small cross-vein.....15
15. Hypopygium plainly notched on apical border.....16
Hypopygium not notched on apical border.....17
16. Thorax yellowish pollinose, first two segments of male abdomen colored like the thorax.....**argentifrons** Hine
Thorax gray pollinose, first two male abdominal segments colored like the following ones.....**argyrosoma** Hine
17. Hypopygium truncate at apex.....**truncatus** Hine
Hypopygium rounded at apex.....**pallidulus** Hine
18. Femora largely red, especially posteriorly.....19
Femora entirely black.....20
19. Male abdominal segments two, three and four with black markings, **argyrogaster** Macquart
Male abdominal segments two, three, four, five and six with black markings, **triton** Osten Sacken
20. Mystax white, scutellum with long white hair and bristles.....21
Mystax yellow, scutellum with yellow or black hair and bristles.....22
21. Very small species, 12 millimeters, mesothorax posteriorly white haired, **pilosus** n. sp.
Larger species, not under 15 millimeters, mesonotum posteriorly black haired.....**coquillettii** n. sp.
22. Mystax bright yellow, scutellum with long yellow hair and bristles, **auripilus** Hine
Mystax pale yellow, scutellum with black hair and bristles.....23
23. Male, first three abdominal segments without silvery markings, female uniformly yellow pollinose.....**plenus** Hine
Male, only first two abdominal segments without silvery markings; female, abdomen with a series of large black markings dorsally, one to each segment.....**nemoralis** Hine

Erax stramineus Williston.

Total length 15 to 18 millimeters. Mystax, beard and hairs of the palpi pale but distinctly yellow, bristles of the front and occipito-orbital bristles sometimes black, but they may be yellow and in most specimens examined at least part of them are pale yellow. Dorsum of the mesothorax with black hairs and bristles in many specimens, but in some the bristles posteriorly, at least are pale; scutellum with a row of many long black or pale bristles on the margin. Wings hyaline, narrow, furcation of the third vein distinctly before the middle of the distance between the anterior cross-vein and the base of the second posterior cell, stump usually near twice as long as the basal section. Legs nearly entirely black in some specimens, tibiæ reddish in others. In many species of the genus the tibiæ normally are widely red basally and narrowly black apically. Here it may be said that the normal color of the legs is uniformly black and the variation toward red appears to be due to the lack of varying amounts of the dark pigment, thus

giving more or less the appearance of a faded condition to the tibiæ and even to the other parts of the legs. Legs with much pale yellow hair and black and some pale bristles. Male. First and second abdominal segments gray pollinose with rather sparse pale hairs, segments three, four and five with prominent white pile parted at the middle and directed outward; segment six similar, but pile much less prominent; segment seven silvery pollinose with short and scattered white hairs. Hypopygium, from dorsal view, rather narrow, sides nearly parallel to apical third then gradually widened; from side view, rather long of nearly the same width throughout and with a prominent extension apically. See Figures 1 and 33. Female, abdomen nearly uniformly gray pollinose, oviduct shining black, somewhat longer than abdominal segments five, six and seven.

Several specimens of both sexes from Montana and Wyoming.

It is quite nearly related to *rapax*, as Osten Sacken stated when he described the latter. The smaller size and the fact that the entire third abdominal segment is silvery seem to distinguish *stramineus*. A quantity of material, including the two species, is at hand from the territory extending from Montana to Guadalajara, Mexico, and I find it difficult to make a satisfactory separation from all localities, but this is easy to do with specimens from the northern and southern limits of the area indicated.

Erax dubius Williston.

There is some doubt of the status of this species, for Williston gave the name in a key in Volume 12, Transaction of the American Entomological Society, page 64, but did not give a description in full. It is reasonably sure, however, that his short diagnosis of *Erax* n. sp., on page 68 of the same paper, refers to *dubius*. A distinct effort has been made to properly identify the species. By correspondence with C. P. Alexander, of the University of Kansas, I find that the specimen which Williston mentions from Washington has been lost, but a specimen from Arizona, very likely that one referred to in the diagnosis, is labelled as the type in the museum at Lawrence. A study of this proves it to be very near *stramineus*, but with black femora and red tibiæ and tarsi. The color of the body is exactly that of *stramineus* and the form of the hypopygium is the same. Williston described *stramineus* as having entirely black legs, but the fact is that in a long series of specimens

variations occur even to the extent of having the tibiæ and tarsi in large measure reddish. It seems best, after considering the facts to regard *dubius* as no more than a variety of *stramineus* if not a synonym.

Several specimens from Wyoming agree with the type specimen of *dubius*.

Erax rapax Osten Sacken.

Total length 20 to 25 millimeters. Mystax, beard and palpal hairs decidedly yellow, frontal and occipito-orbital bristles mostly black. Bristles and hairs of the mesothoracic dorsum largely black, margin of the scutellum with a row of many long bristles which are viarable between black and yellow in different specimens. Wings yellowish hyaline, furcation of the third vein much nearer the small cross than to the base of the second posterior cell, stump distinctly longer than the basal section. Legs black with an abundance of yellow hair, bristles black, but an occasional pale one intermixed. As in stramineus the legs vary in color and many specimens have the bases of the tibiæ reddish while others have the legs generally paler throughout. Male abdomen, segments one, two and anterior part of three dark, nearly black, remainder of three and all of four and five silvery and with silvery hairs parted at the middle and directed outward, six similar but hairs shorter, seven silvery pollinose. Hypopygium black with mostly black pile, although more or less yellow pile is likely to be present. Ventrally this pile is longer and more conspicuous than elsewhere. See Figure 41. Female generally less pilose than the male, abdomen gray pollinose, oviduct shining black, somewhat longer than abdominal segments five, six and seven.

Common in southwestern United States and Mexico. The type locality is Northern Sonora.

This species is difficult to separate from *stramineus* in the northern part of its range.

Erax aurivestitus n. sp.

Male. Total length 22 millimeters. All the vestiture of the head, except the bristles in the region of the ocelli and one or two occipito-orbital bristles on each side, distinctly yellow; head, thorax and base of abdomen yellow pollinose, dorsum of the mesothorax with black hairs and bristles, pleuræ mostly with black hairs and bristles, but with some pale ones intermixed, coxæ with yellow bristles, other parts of legs mostly with abundance of yellow hair and some black bristles, femora black, in ground color, tibiæ and tarsi dark reddish, wings yellowish hyaline, furcation of the third vein distinctly before the middle of the distance between the anterior cross vein and the base of the second posterior cell, stump longer than the basal section. First and second abdominal segments dark in color with mostly dark hairs

both above and beneath; third segment with a peculiar band of long hair, silvery above and darker beneath, extending entirely around it and parted on the mid-dorsum and also on the mid-venter and in each case directed outward; the hairs on the anterior part of the segment are directed somewhat backward and those on the posterior are directed forward to about the same extent; narrow posterior margin of the third segment and segments four to seven inclusive with but very little pile but conspicuously silvery pollinose. Hypopygium black and almost entirely black pilose, but with a little yellow pile basally and also apically; black pile especially long and prominent on sides and venter; dorsally of nearly uniform width, but wider and shorter than in sagax; from side view a very prominent extension at apex. Figure 42.

Male type from Morelos, Mexico, collected by D. C. Crawford, in the author's collection.

The peculiar third abdominal segment and the hypopygium characterize this species.

Erax splendens Williston.

Total length 22 to 25 millimeters. Mystax and beard bright yellow, hair and bristles of the front and the occipito-orbital bristles black, thorax rather sparsely brown pollinose and with black hair, wings yellowish, furcation of the third vein not far from the anterior cross vein, stump a little longer than the basal section. Front legs with dense yellow hair anteriorly on coxæ, and ventrally on femora, tibiæ and tarsi, but there is much black hair on the appendages also; middle ahd hind legs mostly black haired, but there is some variation in a series of specimens. Legs entirely shining black in ground color. Male abdomen black with black vestiture, except segments four, five and six, which are silvery. See Figure 39. Female, abdomen dark, segments two to six inclusive yellowish gray pollinose with rather small irregular markings dorsally. Oviduct shining black, hardly as long as the last three abdominal segments.

Several specimens of both sexes from Guadalajara, Mexico, collected by McClendon.

The very dark color of the body of this species with the bright yellow mystax and beard makes its identification easy.

Erax truncatus Hine.

Thorax yellowish-brown, above, abdomen gray, first four segments with long white hairs, legs black with the exception of the basal part of each tibia which is light reddish. Total length 22 to 30 millimeters.

Mystax and beard white, ocellar, occipito-orbital and a transverse row of bristles on the dorsum of the prothorax black, palpi with black and white hairs intermixed, dorsum of the thorax and the scutellum with many black hairs and bristles, but there are some white ones intermixed, wings hyaline.

First segment of the male abdomen with long white hairs on each side, second, third and fourth segments with long silvery hair parted at the middle and directed outward, fifth, sixth and seventh segments silvery white pollinose, but without long hair; hypopygium rather large, from dorsal view about as wide as the last segment of the abdomen, from side view most prominent near middle above and cut off at tip so as to give a truncate appearance. Figure 45.

First seven segments of the female abdomen silvery white; oviduct slender, shining black, about seven millimeters in length.

Several specimens from the Huachuca Mountains, Arizona, July 28, 1907.

The large compact hypopygium of the male and the long oviduct of the female give this species a distinct appearance which makes its separation from others easy.

Erax pallidulus Hine.

A pale colored species with black legs and hyaline wings. The male has the hypopygium small and, from dorsal view, very narrow. Total length 18 to 28 millimeters. Mystax very pale yellowish, beard white, palpi black with white hair, occipito-orbital and ocellar bristles mostly black; thorax dorsally pale yellowish gray with short black hair anteriorly and black and white bristles and hairs posteriorly, scutellum with pale hairs and bristles, legs black, except bases of tibiæ, which are pale, wings hyaline. Male abdomen silver white, first four segments with long white hair, two, three and four with hair parted at the middle and directed outward, five, six and seven without long hair, hypopygium small, black, narrowed toward apex where, from lateral view, it appears nearly evenly rounded. Figure 44.

Female colored like the male. Oviduct black, only slightly longer than the last two abdominal segments.

Three male specimens and a female from Albuquerque, New Mexico, collected by J. R. Watson, and one female from Colorado.

The short hypopygium and oviduct are characteristic of this species.

Erax argyrosoma Hine.

Body nearly uniformly white all over, mid-dorsal stripe of the thorax not plainly marked. Length 23 to 25 millimeters. Mystax and beard white, palpi black with white hair, some of the occipito-orbital bristles black and some white; legs black except the basal parts of the tibiæ, which are yellowish haired, wings hyaline; anterior part of the dorsum of the thorax with short black hair; posterior part and the scutellum with black and white bristles and hairs. First four abdominal segments of the male with long white hair; on two, three and four, this is parted at the middle and directed outward, segments five, six

and seven silver white, but without long hair, hypopygium black with short white hair, somewhat notched at the apex with the lower part extending into a prominence. Figure 40.

Female abdomen gray pollinose, oviduct shining black, four millimeters in length.

Taken by J. R. Watson near Albuquerque, New Mexico. More than a dozen specimens from other localities in New Mexico and western Texas.

Erax auripilus Hine.

A medium sized species characterized by abundance of rather bright yellow hair on all the parts of the body.

Male. Total length 22 millimeters. All the hairs on the various parts of the head yellow, sternum and sides of the thorax with yellow hair, dorsum with black hair, wings clear hyaline, furcation of the third vein distinctly before the base of the second posterior cell and with a long appendage, costa not enlarged near the tip of the auxiliary vein, posterior branch of the third vein meets the costa distinctly before the tip of the wings; legs with yellow hair and black bristles, in most part black in ground color, but the basal half or more of each tibia is bright yellow; abdomen with yellow hair, segments two to five black above with light colored lateral and hind margins, segments six and seven silvery white, hypopygium of medium size, shining black in ground color and clothed with yellow hair. Figure 47.

One male, taken at Clifton, Texas, May 29, 1907, by E. B. Williamson. A male in the collection of the Academy of Natural Sciences was taken at Round Mountain, Texas. Several females in the U. S. National Museum from different localities in Texas.

Erax canus Hine.

Male. Total length 24 millimeters. General body color rather hoary white produced by white pollen and hair, dorsum of the thorax with black hair and bristles, legs with black bristles, mystax and beard pale yellow, bristles of the front black, palpi black with pale yellow hair and bristles, wings hyaline, costa uniform throughout, furcation of the third vein distinctly before the base of the second posterior cell and with a distinct appendage, the posterior branch of the third vein bends forward to meet the costa plainly before the apex of the wings, legs black with the basal third of each tibia reddish; abdomen uniformly hoary white, segments two, three and four on the dorsum with long white hair parted at the middle and directed outward; hypopygium of medium size, black and clothed with white hair. Figure 38.

Female colored like the male, but abdominal segments two, three and four devoid of the peculiar long hair described for the male. Oviduct shining black, slightly longer than abdominal segments six and seven combined.

Male and several females from Claremont, California, sent in by Carl F. Baker; three males in the U. S. National Museum from Los Angeles County, California, Collection Coquillett. The smallest female measures only 17 millimeters in total length.

Erax eximeus Bellardi.

Total length 17 millimeters. Mystax pale with some black bristles intermixed, beard white, palpi black haired, ocellar and occipito-orbital bristles black. Thorax with black hairs and bristles, scutellum with several black, marginal bristles; femora reddish posteriorly and at apex, black anteriorly, tibiæ and tarsi largely red with mostly white hairs and black bristles, wings very slightly smoky hyaline, branching of the third vein midway between the small cross vein and the base of the second posterior cell, stump only very slightly longer than the basal section. Abdomen largely gray, first segment, anterior two-thirds of second and the anterior parts of segments three and four black, posterior part of the second and nearly all of the third and fourth with long hair parted at the middle and directed outward; segments five, six and seven with much shorter hair. Hypopygium dark red, black in places. See Figure 46.

A male specimen from Cuernavaca, Mexico, collected by D. L. Crawford.

This species does not answer in detail to *eximeus*, but goes there in Bellardi's Key. It is the only *Erax* I have with the apexes of the femora red following black.

Erax inflatus Hine.

A dark colored species with the mystax composed of black and gray hairs intermixed, wings hyaline, slightly fumose at apices, legs black with the exception of the extreme bases of the tibiæ which are yellowish red. Length of the males 20 to 25 millimeters; of the females 22 to 26 millimeters.

Front yellowish-gray pollinose, antennæ black, first two segments clothed with gray hair, occipito-orbital bristles and ocellar bristles black, mystax composed of black and gray hairs intermixed, beard silky white, palpi black with black hairs; thorax brownish-gray pollinose with a dark mid-dorsal stripe abbreviated posteriorly, clothed with gray and black hairs and bristles existing in different proportions in different specimens; legs black except the extreme apices of the tibia, which are yellowish-red, furnished with white hairs and black bristles and some golden pile on the underside of some of the segments; wings hyaline, slightly darkened at apex.

Male abdomen with the apex of the second segment and all of the segments from three to seven inclusive silver white, segments two and three with long white hair parted at the middle and directed outward,

four and five shows this arrangement somewhat, but the hairs are short; hypopygium clothed mostly with white hair, enlarged at apical half until it is nearly twice as wide as the seventh abdominal segment.

Female abdomen with each segment white pollinose at sides and apex, otherwise black above, oviduct black, scarcely five millimeters in length, equivalent to the last three abdominal segments.

Twenty specimens received from F. Grinnel, Jr., and taken in Los Angeles County, California. A very distinct species on account of the male hypopygium which appears as if inflated and is nearly twice as wide as the seventh abdominal segment. Males and females from Los Angeles, Kern and San Bernardino counties, California, Coquillet Collection.

Erax nemoralis Hine.

A dark colored species with yellowish mystax and fumose wings. Femora, tarsi and apices of the tibiæ black, bases of tibiæ reddish-brown. Length, male, about 25 millimeters; female, to the tip of the oviduct, 24 to 27 millimeters. Face and front covered with yellowish dust, mystax and beard pale yellow, occipito-orbital and ocellar bristles black, as are most all of the hairs and bristles of the front, palpi black, furnished with many black hairs which often are intermixed with pale yellow ones. Prothorax mostly clothed with pale hairs, remainder of thorax with many black hairs and bristles, but these often are reduced by the presence of greater or less numbers of pale ones; mid-dorsal stripe dark and well marked, abbreviated behind and divided anteriorly, on either side the markings are in the form of ill-defined spots caused by the difference in intensity of the rust-colored dust which gives the thorax its peculiar color; legs black, except the bases of the tibiæ, which are reddish-brown, clothed with black bristles and pale hairs of different lengths, the shorter ones recumbent, some of the segments inwardly, more especially the metatarsi and front tibia, clothed with golden recumbent pile.

In the male abdominal segments one, two and base of three dark, largely clothed with black hair, apex of three and all of four, with the exception of a small black triangle on each anteriorly, white with long white hair parted in the middle and directed outward, five and six silver white with very short hair, remainder of abdomen black, with black hair, however, in some specimens part of seven is whitish and there may be a few pale hairs on the hypopygium. Figure 51.

In the female the segments of the abdomen are gray on the sides and hind margin, otherwise black above, but the latter color is not well defined, especially if viewed with a lense; oviduct about six millimeters in length, equivalent to the last four abdominal segments.

Several specimens of both sexes procured in a brushy woodland at New Roads, Louisiana, July 15, 1905. The specimens were captured while resting near or on the ground.

It is a predaceous insect of possible value on account of its size. Other specimens from Texas and from Falls Church, Virginia.

Erax argentifrons Hine.

Much like rapax. Front white pollinose, mystax white, legs with white hair. Length 18 to 23 millimeters.

Palpi black with white hair, occipito-orbital and ocellar bristles black, antennæ black, first two segments with white hair, beard white. Thorax yellowish-brown with the usual mid-dorsal stripe darker, hairs of sides almost uniformly pale, of dorsum variable between pale yellowish and black; wings hyaline, legs black, except the extreme bases of the tibiæ, which are reddish-yellow, clothed with pale hairs and black bristles. First two segments of the male abdomen colored like the thorax, segments three to seven inclusive silver white, apex of two, all of three and four with long white hair parted at the middle and directed outward, hypopygium much narrower than in stramineus, clothed with black and white hair and distinctly notched at the apex. Figure 35.

Female abdomen uniformly yellowish pollinose and clothed with pale hairs, oviduct about four millimeters in length, equivalent to the last three abdominal segments.

Specimens of both sexes taken in Clark County, Kansas, by Dr. F. H. Snow.

As has been stated, the species has much the appearance of *rapax*, but the somewhat stouter form, the white mystax and beard and much slenderer hypopygium designate it as wholly distinct from that species.

Erax plenus Hine.

A large, robust species, varying in length from 23 to 30 millimeters. Male. Total length 27 millimeters, antennæ black, style nearly twice as long as the third segment, palpi black and clothed with pale yellow hair, face and cheeks with abundance of pale yellowish hairs, ocellar bristles and several bristles on the upper part of the occiput black. Thorax yellow pollinose with most of the hairs and bristles black; wings with a very pale yellowish tinge, costa not thickened near the tip of the auxiliary vein, furcation of the third far before the base of the second posterior cell and with a distinct appendage, posterior branch of the third vein reaches the costa distinctly before the tip of the wing; legs clothed with pale yellowish hairs and black bristles, black, except the tibia which is largely reddish. First three abdominal segments dark, mostly with black hair above and white hair beneath, four white with long white hair parted in the middle and directed outward; five, six and seven white, hypopygium dark in color, short and somewhat tumid. Figure 48.

Female unusually robust for an Erax. Abdomen, except the oviduct, uniformly pale yellowish pollinose, oviduct shining black, about as long as abdominal segments five, six and seven combined. Otherwise colored as in the male.

Several specimens of each sex from Douglas County, Kansas, 900 feet elevation (F. H. Snow). From Onaga, Kansas, and from Osborne County, Kansas, 1557 feet elevation, collected August 3, 1912, (F. X. Williams), Ardmore, Indian Territory, (C. R. Jones); Plano, Texas, (Tucker); Waco, Texas, (Belfrage), and other localities in Texas.

A male from Onaga, Kansas, taken August 20, 1901, is like the other males, except that abdominal segment seven is black instead of silver white. This gives the specimen quite a different appearance, but since similar variations have been observed in other species of the genus it is not considered specific here.

Erax coquillettii n. sp.

Male. Total length 16 millimeters. Mystax and beard white, ocellar tubercle and posterior orbits above with black bristles, mesothorax with black hair and bristles. Scutellum with abundance of long white hair on the disc and numerous mostly white bristles on the margin, wings hyaline, furcation of the third vein distinctly anterior to the vein which closes the discal cell, but plainly beyond the middle of the distance between this vein and the anterior cross-vein, stump of the anterior branch much longer than the basal section. Femora black, tibiæ yellowish red with the extreme apexes dark, tibiæ dark red, legs with white hair and black and white bristles. Abdominal segments one, two and basal part of three black in ground color and only sparsely hairy, apical part of three and all of four and five densely silver-white and white hairy, parted at the middle and directed outward, six and seven silvery with very short hair. Hypopygium from dorsal view narrow on basal third, much widened apically where the width is nearly double that at the base. See Figure 14.

Female colored like the male. Abdomen shining black, each segment gray pollinose posteriorly, giving a distinct banded effect. Oviduct shining black, about as long as the last four abdominal segments.

Type male and allotype from San Diego County, California, collected by Coquillett in April. In the United States National Museum. Several other specimens of both sexes with the same data.

The inflated appearance of the apical half of the male genitalia, the nearly naked first and second abdominal segments which are black in the male, and the banded abdomen of the female suggests the species.

Erax pilosus n. sp.

Male. Total length 11 millimeters. Hair and bristles of the whole body white, except about four black bristles above the base of each wing, numerous white bristles on the margin of the scutellum; wings delicate hyaline, narrow, the third vein branches near the middle of the distance between the anterior cross vein and the apex of the discal cell, stump on the anterior branch much shorter than the basal section. Femora all black, remainder of legs red with extreme apexes of tibiæ darkened. Abdomen, except the first segment and anterior part of the second, with abundant silver-white hair parted at the middle and directed outward. Hypopygium from dorsal view of uniform width for almost basal half, then gradually widened and rounded at tip; from side view nearly uniformly convex dorsally and concave ventrally. See Figure 15.

Male type from El Paso, Texas, April 5, 1902. Collection Academy of Natural Sciences, Philadelphia.

The small size, delicate appearance, male genitalia and furry abdomen are characteristic of the species. I know of no *Erax* where the long white hair of the male abdomen extends to the tip of the seventh segment as in this one.

Erax californicus Schaeffer.

Male. Total length 24 millimeters. Vestiture of the head white, with the exception of the ocellar and occipito-orbital bristles which are black; mesothorax largely white hairy, but some black bristles near the wing bases and some short black hair on the anterior part of the dorsum. Legs long white hairy and with black bristles, femora black, tibiæ and tarsi largely red; wings hyaline, furcation of the third vein very near the middle of the distance between the small cross vein and the base of the second posterior cell, stump slightly longer than the basal section. Abdomen black, largely covered with white pollen and everywhere with white hair, longer on two, three and four and directed outward. Hypopygium from the side of nearly uniform width, rather obliquely truncate at apex, with a rounded prominence above and a tuft of white hair pointing backward below. See Figure 6.

A female from the same locality is colored like the male. Oviduct fully as long as the last three abdominal segments.

The most characteristic thing about the species is the absence in the male of distinct silvery abdominal segments, contrasting with others that are not silvery. The whole abdomen is white pollinose, but in no place is this so dense that it may be said to be silvery as in most species.

More than 20 specimens of both sexes ranging from Washington and Montana to California and Nevada, vary in size from 18 to 26 millimeters and show quite an amount of variation in the color of the tibiæ and tarsi.

The type, which Mr. Schaeffer kindly sent me for study, is in Brooklyn, and was collected in Shasta County, California.

Erax texanus Banks n. sp.

Male. Total length 23 millimeters. Head white-haired; palpi black haired, ocellar and upper orbital bristles black. Thorax with short black hair, pleura white haired. Abdomen without parted hair, the basal segment with long white hair on the sides and beneath, and the apical parts of the segments whitish pollinose, sixth and seventh silvery, sixth blackish at base. Abdomen rather long and slender, the hypopygium much narrower than the last segment, long and slender, black haired. Femora black, tibiæ reddish on basal part, black beyond, tarsi almost black, femur black haired above, beneath and the tibia white haired, except that the latter has dark hair near the tip. Wings with costa normal, third vein with end before wing tip, the fork very much before the base of the second posterior cell. Figure 43.

From Texas (Lafr.). The hypopygium is much longer than in *Erax varipes*.

Erax triton Osten Sacken.

Face yellowish-pollinose; facial tubercle prominent, with a tuft of pale yellowish hairs and bristles; palpi beset with black bristles, mixed with yellow ones; cheeks with soft, whitish hair; upper occipital orbit with a row of stiff black bristles; basal joints of the antennæ reddish, the third joint darker; arista much longer than the third joint. Thorax with a well-marked, broad, dark brown dorso-central stripe, its median line feebly marked, reddish; sides of the dorsum yellowish, with slight brassy reflections; pleuræ brownish-yellow, with soft pale hairs; scutellum yellowish-gray pollinose, with black macrochaetæ. Halteres reddish-yellow. Abdomen, male, its prevailing color, an impure, somewhat silvery, white, with a row of black triangles, the triangles gradually diminishing in size from segment two to segment five, segment six with only a brownish line in the middle; segment one blackish, with some grayish pollen on the sides; forceps rather large, elongate, reddish-brown, beset with paler hairs and with a brush of hairs on the underside, in shape like those of E. anomalus. Female, the black triangles of nearly equal size on segments two to four, occupying the whole middle of the segment and touching the hind margin with the apex; the sides of the segments filled by triangles of an impure silvery-white; on segments six and seven the lateral margins only whitish, the middle occupied by an opaque square of brownish-black; segment five forms the transition in both sexes, but principally in the male; the silvery parts of segments two to four beset with sparse white hairs, combed outwards; ovipositor comparatively short, equal to about two or two and a half of the preceding segments; legs deep reddish, with the usual appressed pubescence or whitish hairs and long, soft, whitish or yellowish hairs (especially in the male) and black bristles; femora black on the underside. Wings

with a slight yellowish-brown tinge; second submarginal cell distinctly appendiculate, rather long, its proximal end reaching considerably beyond the proximal end of the second posterior cell; no incrassation of the costa in the male. Length 23 to 25 millimeters; without ovipositor 22 to 23 millimeters, with it about 26 millimeters.

Erax argyrogaster Macquart.

Total length 22 millimeters. Vestiture of the head pale yellowish, except the palpæ bristles are black, as are some of the occipito-orbital bristles, legs largely red, femora black beneath only, bristles black; wings yellowish, branching of the third vein just beyond the middle of the distance between the small cross-vein and the base of the second posterior cell, stump about the length of the basal section. Abdomen largely white, first segment dark, second with a large black triangle, including more than half of the anterior part of the segment, third with a smaller black triangle, fourth and each following segments with a narrow black mid-dorsal line which on five, six and seven is almost obsolete. Hypopygium elongate, narrow and reddish in color.

One male from Tehauntepec, Mexico, (Sumichrast). This agrees well with Macquart's description. I have not sufficient material to make a comparative study of *argyrogaster* and *triton*, but they appear to be much alike and perhaps the same species.

Erax varipes Williston.

Total length 22 to 28 millimeters. A rather large and robust ash-colored species with pale bristles everywhere. There may be some black in front of the scutellum and on the legs and in some specimens the bristles of the legs are largely black, although in the material studied at least a few white bristles appear scattered irregularly. Hair and bristles of the whole head entirely pale, short hair on anterior part of mesothorax black, scutellum with numerous pale bristles on its margin, wings hyaline, furcation of the third vein much nearer the anterior cross-vein than the apex of the discal cell, making the second submarginal cell very long. Legs variable in color, sometimes largely reddish, but usually the femora dorsally and the tibiæ basally are reddish with the other parts dark. Abdomen nearly uniformly gray and rather short pilose in both sexes; in the male there is not much indication of the pile parting at the middle and pointing outward as in most species with which varipes appears to be most nearly related. From dorsal view male genitalia dark reddish, basally about as wide as the seventh abdominal segment, sides parallel to near the middle, then rather rapidly widened and rounded apically as in Figure 59. For lateral view see Figure 49. Oviduct mostly black, slightly longer than abdominal segments six and seven.

Specimens from Western Kansas and from Arizona.

The dorsal red stripe of each femur and the male genitalia are very characteristic of the species.

Erax interruptus Macquart.

Length 22 to 27 millimeters. General color brownish, mystax pale with a few black bristles above, palpi with black bristles, beard pale, thorax largely gray pollinose with a wide, dark mid-dorsal stripe narrowly divided before. Scutellum with many black bristles on the margin; wings reddish hyaline, legs largely reddish brown, under sides of femora and tibiæ dark, nearly black. Abdomen nearly black in ground color, yellowish-gray pollinose spots on the hind corners of the segments, not meeting at the middle on segments one to four, segments five with the posterior margin pollinose, segments six and seven wholly pollinose in the male and each with a small black triangle with the base posterior, in the female.

This common species is easily known by the furcate male genitalia and the conical oviduct, not compressed as in other species of the genus and about as long as abdominal segments six and seven. See Figure 37.

It is widely distributed South, reaching from Coast to Coast, from the latitude of Kansas to Gautemala and even further south. It was one of the early North American species described and has had several names applied to it as may be seen in the list of synonyms on a previous page.

EXPLANATION OF PLATES VII, VIII AND IX.

Wing of Erax:

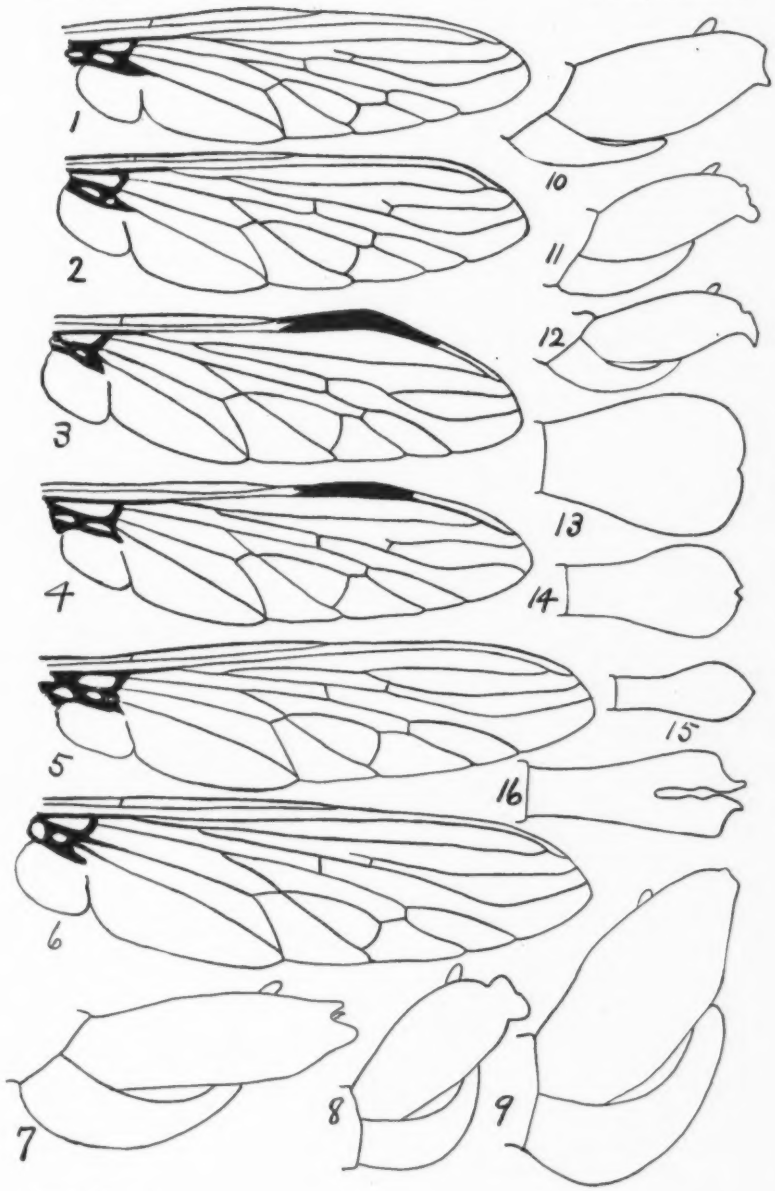
1, *stramineus;* 2, *barbatus;* 3, *jubatus;* 4, *aestuans;* 5, *anomalus;* 6, *californicus.*

Hypopygium of Erax, dorsal view:

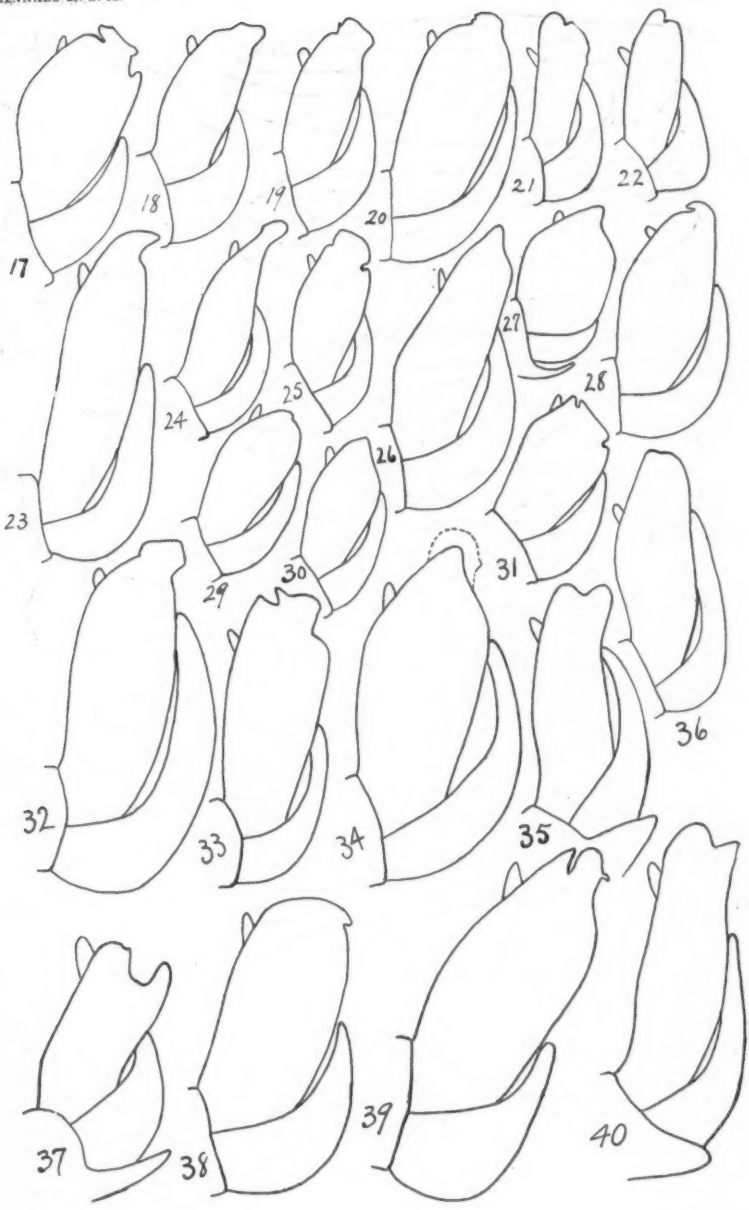
13, *prattii;* 14, *coquillettii;* 15, *pilosus;* 16, *tabescens;* 59, *varipes.*

Hypopygium of Erax, lateral view:

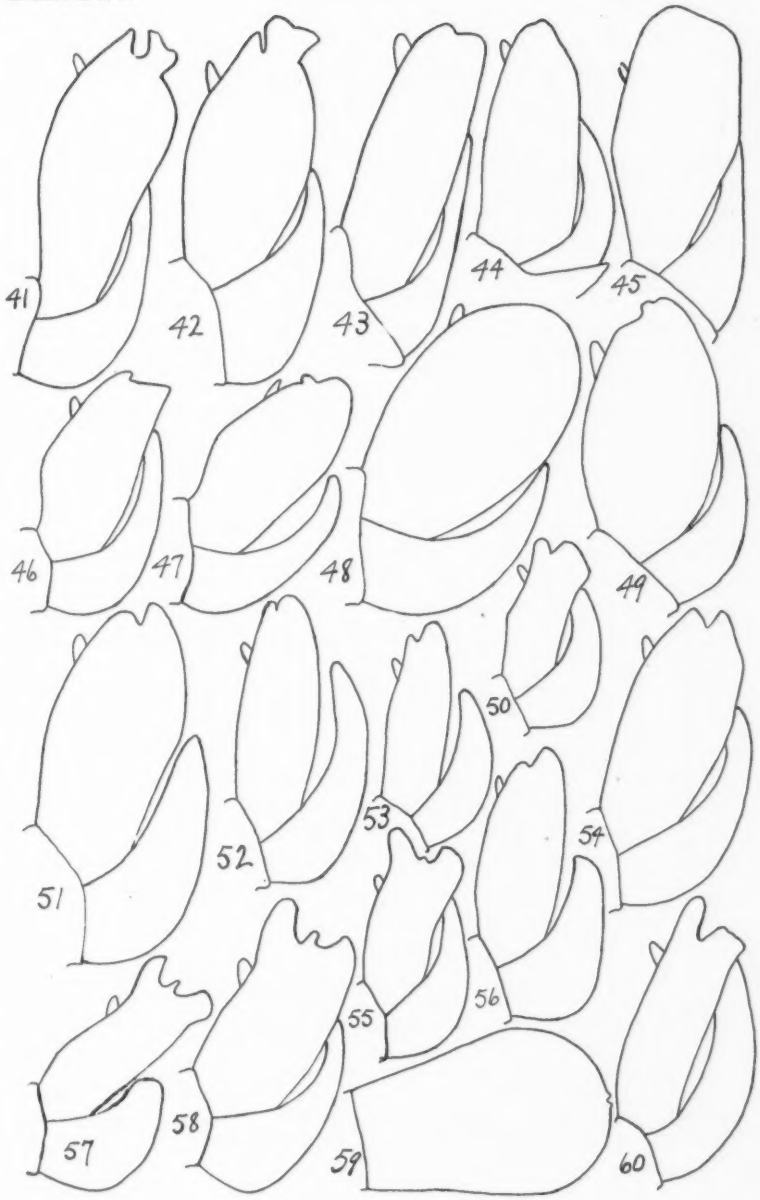
7, *willistoni;* 8, *barbatus;* 9, *bicolor;* 10, *anomalus;* 11, *candidus;* 12, *pernicis;* 17, *æstuans;* 18, *apicalis;* 19, *kansensis;* 20, *loewii;* 21, *belfragei;* 22, *aurimystaceus;* 23, *fulvibarbis;* 24, *portoricensis;* 25, *slossonæ;* 26, *tabescens;* 27, *mexicanus;* 28, *affinis;* 29, *nigritarsis;* 30, *rufitibia;* 31, *nigrimystaceus;* 32, *stylatus;* 33, *stramineus;* 34, *cingulatus;* 35, *argentifrons;* 36, *haloesus;* 37, *interruptus;* 38, *canus;* 39, *splendens;* 40, *argyrosoma;* 41, *rapax;* 42, *aurivestitus;* 43, *texanus;* 44, *pallidulus;* 45, *truncatus;* 46, *eximeus;* 47, *auripilus;* 48, *plenus;* 49, *varipes;* 50, *cressoni;* 51, *nemoralis;* 52, *subcupreus;* 53, *costalis;* 54, *jubatus;* 55, *parvulus;* 56, *latrunculus;* 57, *concinnatus;* 58, *carinatus;* 60, *unicolor.*



Jas. S. Hine



Jas. S. Hine



Jas. S. Hine

SOME CHALCID-WASPS REARED FROM CECIDOMYID GALLS.

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All except two of the species of Chalcidoidea described and listed in this paper are stated by the collectors, Mr. V. L. Wildermuth and Mr. E. G. Smyth, to have been reared from galls of the alfalfa gall-midge, *Asphondylia websteri* Felt. The two exceptions were reared from unidentified gall-making Cecidomyids, one being from a gall on *Pluchea borealis* and the other on *Suaeda* sp.

Of the species reared from galls of *Asphondylia websteri* the exact host relations of some are unknown. Some are undoubtedly primary parasites of the midge, while others are believed to be secondary upon that host. The clover seed-chalcid, *Bruchophagus funebris* Howard, was reared from some of the galls along with the parasites and it is possible that some of the parasites may have had this seed-chalcid for host. Mr. Wildermuth states that all specimens reared under Tempe Nos. 2223, 2224 and 2251 were reared from dissected *Asphondylia websteri* material and are therefore positively known to be either primary or secondary parasites of the midge. The material under Tempe No. 2264 was reared from collected galls of *Asphondylia websteri* placed in vials, and hence the host relations of this material can only be surmised. It was in the lot of material under this number that *Bruchophagus funebris* was found and it is probable as will be pointed out under discussion of the species that at least one species of parasite, *Tetrastichus bruchophagi*, came from this host.

Family EURYTOMIDÆ.

Eurytoma medicaginis new species.

Female. Length 2 mm. Head and thorax with strong umbilicate-punctate sculpture and thinly clothed with short silvery white hairs. Antennæ rather short; scape not reaching the front ocellus; pedicel conical, narrower and scarcely as long as the first funicle joint; ring-joint small; funicle five-jointed, the joints, except the first, subquadrate; the first joint slightly longer than broad, the fifth slightly broader than

long; club three-jointed, a little broader than the funicle, and not quite equal in length to the three preceding funicle joints combined, the basal joint subquadrate; second joint as long as the basal; third joint conical; ocelli in a very low triangle, the postocellar line more than twice the length of the ocellocular line; occiput immargined above, cheeks margined posteriorly; dorsal portion of pronotum very nearly as broad as the mesonotum and distinctly shorter than the mesoscutum; mesepisternum granularly rugulose, the mesepimeron indistinctly, longitudinally striate; propodeum very nearly perpendicular to the apex of scutellum, broadly but very shallowly impressed medially, the impressed area granularly rugulose; remainder of propodeum more coarsely rugose; marginal and postmarginal veins practically equal, the stigmal about three-fourths the marginal; abdominal petiole nearly twice as long as the hind coxæ, rather slender, flattened and nearly smooth above, longitudinally striate at sides and beneath, and joining the main part of abdomen ventrally, or, at least, at the antero-ventral angle; body of abdomen subglobose and ending in a short sharp point, strongly compressed from the sides, very strongly arched above the attachment of petiole as viewed from the sides, a little longer than the head and thorax combined and viewed laterally not one-third longer than thick dorso-ventrally; fifth segment the largest, approximately twice the length of fourth on the median dorsal line; ovipositor slightly exposed at tip; hind coxæ granularly rugulose like the middle of propodeum. Black; flagellum dark brown; scape brownish testaceous; coxæ and femora black; apices of femora and all tibiæ yellowish brown; all tarsi pale yellowish, claws brown; wings hyaline, venation brownish.

Male. Length 1.35 mm. Scape somewhat swollen beneath, reaching to the front ocellus; pedicel globose; between pedicel and first funicle one small ring-joint; funicle five-jointed, the joints, except the fifth, narrowed at apex into a distinct neck, each joint about twice as long as the thickened portion is thick and bearing hairs about twice as long as the length of segment; neck on apex of first segment shorter than on the other segments and the thickened portion longer; fifth segment not narrowed at apex, about twice as long as thick, with the hairs shorter than on the other segments; between each of joints two, three, four, and five of the funicle is what appears to be a very small transverse ring-joint, (visible only in balsam-mounted specimens); club two-jointed, the joints subequal in length, the apical joint ending in a very short inconspicuous nipple-like point; the propodeum is usually nearly uniformly reticulately rugose all over, the sculpture of the depressed area not markedly different from the rest of the surface; abdominal petiole longer than the hind coxæ, but not twice as long, slender, and weakly shagreened, not striate; body of abdomen small globose, hardly more than half as long as the thorax. Otherwise similar to the female, but with all tibiæ mostly blackish-brown.

Type locality, Tempe, Arizona. Type, Cat. No. 22295, U. S. Nat. Mus.

Host: *Asphondylia websteri* Felt.

Type, allotype and seven paratypes reared by V. L. Wildermuth from galls of the alfalfa midge and recorded under Webster No. 7268, Tempe No. 2251. Also a large series of specimens from the same host and locality reared by Wildermuth under Tempe No. 2264.

Antenna of type female on Hymenoptera Slide No. 781, and antennæ of a male and a female paratype on Hymenoptera Slide No. 782, U. S. Nat. Mus.

Bruchophagus funebris Howard.

Specimens of this seed-chalcid were reared by Mr. Wildermuth from galls of *Asphondylia websteri* at Tempe, Arizona, under Tempe No. 2264. Its presence in these galls is undoubtedly accounted for by the fact that it not infrequently happens that developed seeds of alfalfa are present within the gall formed by the midge and these seeds afford opportunity for the development of the *Bruchophagus*.

Family CALLIMOMIDÆ.

Callimome asphondyliæ, new species.

Female. Length 2.25 mm. Head and thorax shagreened above; face below antennæ less strongly sculptured than the vertex; antennæ rather short and thick; funicle seven-jointed, the funicle joints subequal in length, but increasing slightly in breadth toward the apex, and all joints broader than long, the first only slightly so, the last about half as long as thick; club three-jointed, not as long as the three preceding funicle joints; ocelli in a low triangle, the lateral ocellus separated from eye-margin by about the long diameter of the ocellus; parapsidal grooves complete, but weakly impressed posteriorly; propodeum without carinæ and uniformly shagreened, the sculpture not as strong as on scutellum; hind coxæ laterally sculptured like the scutellum; hind femora outwardly sculptured about like the propodeum; wings sparsely ciliated, the cilia more or less arranged in rows; stigmal vein very short, postmarginal also short; abdomen about equal to the thorax in length, the first tergite smooth, other tergites weakly sculptured, more strongly so at sides; ovipositor extending beyond the apex of abdomen about one and one-third times the length of abdomen. Color, dull blackish green, the head and thorax sparsely clothed with silvery white hairs; eyes pale reddish; face, propodeum, hind femora and the abdomen more strongly metallic than dorsum of thorax; sides of thorax and hind coxæ bluish; antennal scape and all tibiæ and tarsi brownish testaceous; flagellum, median and front femora, tarsal claws and ovipositor sheaths brownish black; wings hyaline; venation pale brownish.

Male. Length 2 mm. Tibiæ all dark brown. Otherwise agrees with the female except the general color is perhaps a little darker.

Type locality, Tempe, Arizona. Type, Cat. No. 22296, U. S. Nat. Mus.

Host, *Asphondylia websteri* Felt.

Six females and two males reared by V. L. Wildermuth from galls of the alfalfa midge under Webster No. 7268, Tempe No. 2251. May be a secondary parasite of *Asphondylia*, but is more likely primary.

Syntomaspis medicaginis, new species.

Closely resembles *Syntomaspis thalassimus* Crosby, but differs by having the antennal scape pale testaceous, the face more deeply concave and more hairy, the mesoscutum and scutellum more deeply and closely sculptured and therefore less shining, the axillæ a little more widely separated and the tibiæ not so dark.

Female. Length 2 mm. Face more than ordinarily deeply concave, rather strongly sculptured and closely set with silvery hairs; lateral ocelli separated from the eye-margin by about the diameter of an ocellus or a little less; first joint of funicle a little broader than long, following joints decreasing gradually in length outwardly; club barely longer than the two preceding funicle joints; mesoscutum, axillæ and scutellum deeply, closely reticulate-punctate, subopaque; cross furrow on scutellum distinct, the surface behind the cross-furrow reticulately sculptured but not quite as deeply and finely so as the rest of scutellum; propodeum weakly reticulated, shining, with a few foveolate punctures on the anterior margin but without carinæ, the spiracles elliptical; discal ciliation of the forewing arranged in distinct rows and confined to the area distad of a line running obliquely basad from the stigmal vein to the posterior margin; the base of wing and a broad wedge-shaped area immediately beneath and extending the whole length of marginal vein entirely bare or with only a very few very weak cilia; in the apical portion of the wing a distinct row of cilia runs from the stigmal vein in a broad curve to the apical middle of wing; abdomen very slightly longer than the thorax, distinctly though not deeply reticulated, shining, the first tergite nearly smooth, tergites one to three emarginate at the middle; ovipositor exserted the length of thorax and abdomen. Head, thorax, abdomen, coxæ and all femora metallic green, thoracic pleura and the coxæ strongly tinged with purplish or blackish; antennal pedicel and flagellum brownish-black; antennal scape, all tibiæ and tarsi and the ovipositor brownish-testaceous; eyes pale reddish; wings hyaline, venation pale yellowish.

Male. Length 1.7 mm. Agrees with the female except that the scape is somewhat metallic, the dorsum of thorax is slightly more shining, the cross furrow on scutellum less distinct, the tibiæ except at apex are all blackish with more or less of a metallic lustre, and the abdomen is much shorter and smaller than the thorax.

Type locality, Tempe, Arizona. 'Type,' Cat. No. 22297, U. S. Nat. Mus.

Host, *Asphondylia websteri* Felt.

Type female reared by V. L. Wildermuth from galls of the alfalfa midge and recorded under Webster No. 7268, Tempe No. 2264. One paratype with the same data except Tempe No. 2251. Allotype, four male paratypes and five female paratypes reared by E. G. Smyth at Tempe from the galls of the same insect and recorded under the same Webster number. Wing of a female paratype mounted on a slide.

Syntomaspis umbilicata, new species.

In the sculpture of the thorax resembles *elegantissima* Ashmead, and *warreni* Cockerell, but is easily distinguished from both by the much shorter funicle joints, metallic colored femora and the smaller size.

Female. Length 2.5 mm. Head viewed from in front about as long as broad; face strongly sculptured with large shallow punctures; antennal depression deep and nearly smooth within, the antennæ separated at base by a carinate ridge; postocellar line equal to twice the ocellocular line, the lateral ocelli not farther from the eye-margin than the diameter of an ocellus; antennal pedicel conical, about equal in length to the first funicle joint; ring-joint a little more than twice as broad as long; first funicle joint nearly quadrate, following joints diminishing very gradually in length, the last about two-thirds as long as broad; club three-jointed, not broader than the funicle and about as long as the three preceding funicle joints; pronotum rugulose; mesoscutum with large, closely placed umbilicate punctures; surface of the scutellum before the distinct cross-furrow sculptured like the mesoscutum, behind the cross-furrow finely reticulately sculptured; propodeum polished, without carinæ and with a row of large punctures along the anterior margin; ciliation of the forewing similar to that figured for *Syntomaspis medicaginis* (ante), but not so distinctly arranged in rows, the row running from stigmal vein to apex of wing present, but very poorly defined and the wedge-shaped hairless area behind the marginal vein somewhat more restricted, there being three or four coarse cilia basad of the stigmal vein in the apex of the wedge; hind coxæ about twice as long as thick with the dorso-posterior angle weakly carinately margined; abdomen about as long as the thorax; first, second, and third tergites emarginate medially, dorsally mostly polished; the second and third at sides, and the fourth entirely, distinctly reticulate; ovipositor exserted the length of the body; color of head and thorax above dull coppery green; propodeum polished metallic green; pleura, coxæ and all femora metallic greenish-black or bluish in some lights; first three tergites above steel-blue, sides of the abdomen and dorsum beyond the third tergite brassy-green; antennal pedicel and flagellum

brownish-black, more or less metallic; scape, all tibiæ, and tarsi reddish testaceous; ovipositor sheaths black; wings hyaline, venation pale yellowish.

Male. Length 2 mm. Antennal pedicel a little shorter than the first funicle joint; first funicle joint slightly broader than long and not longer than the second; joints beyond the second very slightly diminishing in length; sculpture of scutellum like that of female but the cross-furrow not distinctly impressed; propodeum faintly rugulose with a very weak median carina; abdomen a little shorter than the thorax, the tergites not distinctly emarginate medially; scape dark above, reddish testaceous beneath; all tibiæ brownish-black; tarsi pale yellowish. Otherwise like the female.

Type locality, Tempe, Arizona. Type, Cat. No. 22298, U. S. Nat. Mus.

Female type, male allotype and two male paratypes reared by Mr. V. L. Wildermuth from galls of a Cecidomyiid on *Suaeda* species and recorded under Tempe No. 2741.

Family PTEROMALIDÆ.

Pseudocatolaccus americanus, new species.

This species is apparently very similar to *Pseudocatolaccus asphondyliæ* Masi, Boll. Lab. Zool. Agr., Portici, 3, 1908, p. 139 (—*Pteromalus polyphagus* Foerster, according to Kurdjumov, Rev. Russe d'Entom. 13, 1913, p. 7) differing principally from the description of that species in its smaller size, somewhat shorter malar space, slightly shorter antennal joints and the more acute second and third teeth of the mandibles.

Female. Length 2.5 mm. Head and thorax strongly reticulate-punctate, the sculpture of mesonotum somewhat stronger than that of the head. Head fully four times as broad as long, as viewed from above; ocelli in a low triangle, postocellar line a little shorter than the ocellocular line; as viewed from in front the head is distinctly broader than long, antennæ inserted above the lower extremity of eyes, malar space shorter than the height of eye, clypeus irregularly striate, its anterior margin sinuate; cheeks at base of mandibles distinctly concave; mandibles four-toothed, the outer tooth acute, two median teeth subacute, inner tooth blunt at apex; antennal scape cylindrical and not reaching the anterior ocellus; pedicel conical and longer than thick; three ring-joints strongly transverse, about equal in length but increasing in breadth from first to third; funicle five-jointed, the first joint about one-third longer than broad, following joints decreasing slightly in length, the fifth subquadrate or very slightly broader than long; club slightly thicker than the funicle, three-jointed, and about twice as long as the fifth funicle joint; mesoscutum much broader than long, the parapsidal grooves weakly impressed on the anterior half; scutellum

as long or a little longer than the mesoscutum; propodeum short, mostly sculptureless with a weak median carina and strong lateral folds, the spiracles elliptical and close to the anterior margin of propodeum; wings hyaline, the area before the submarginal vein with a few cilia apically; behind the submarginal bare; ciliation of the rest of wing rather sparse; stigmal and postmarginal veins subequal and each about four-fifths the length of marginal; abdomen about as long as head and thorax, conic-ovate and somewhat narrower than the thorax. Head and thorax aeneous, scape pale testaceous; flagellum dark brown; mandibles brownish; coxæ concolorous with the thorax; all femora brownish-black; all tibiæ brownish except at apex which is pale yellowish like the tarsi; apical joint of all tarsi dark; abdomen metallic blue-green at base, bronzy black beyond.

Male. Length 2 mm. Scape reaching the front ocellus, antennæ with two ring-joints and a six-jointed funicle, the funicle joints subequal and slightly longer than broad; ocellocular and postocellar lines about equal; abdomen not as long as the head and thorax; color of head and thorax metallic blue-green; all femora dark brown; all tibiæ and tarsi pale yellowish, the apical tarsal joint dark; otherwise like the female.

Type locality, Tempe, Arizona. Type, Cat. No. 22299, U. S. Nat. Mus.

Host, *Asphondylia websteri* Felt.

Described from eight females and one male reared by V. L. Wildermuth from the alfalfa midge under Webster No. 7268, Tempe No. 2251. Also one female and one male from the same locality and host reared by Mr. Wildermuth under Tempe No. 2224.

Mouthparts and antenna of a female paratype mounted on a slide (Hymenoptera Slide No. 783, U. S. Nat. Mus.) Other type material mounted on card points.

This species, according to Mr. Wildermuth, is known to be a true parasite of *Asphondylia websteri* Felt.

Trimeromicrus maculatus Gahan.

One specimen of this species, reared under Tempe No. 2223 is, according to Mr. Wildermuth, known to have been a true secondary parasite of *Asphondylia websteri*, having been dissected out of that host and then reared to maturity. Other specimens of the species were reared under Tempe No. 2264 from galls of *Asphondylia websteri* along with a number of other hymenopterous parasites and including several specimens of *Bruchophagus funebris*.

Trimeromicrus maculatus was originally recorded as a parasite in alfalfa seed-pods infested with *Bruchophagus funebris*, and subsequently proven by Mr. T. D. Urbahns to be a primary parasite upon that host. The record under Tempe No. 2223 is interesting as showing that this species may develop upon parasitic forms of Hymenoptera as well as upon the plant-feeding *Bruchophagus funebris*. In the case of the record under Tempe No. 2264 it is impossible to say whether the specimens of this species were parasitic upon *Bruchophagus*, which was shown to be present in the *Asphondylia* galls, or whether it was actually present in its role of a secondary parasite of *Asphondylia*.

Family EULOPHIDÆ.

Tetrastichus sobrius, new species.

Female. Length 1.8 mm. Face reticulately shagreened, with two longitudinal rows of shallow punctures between the antenna and eye-margin; antennal pedicel slightly shorter than the first funicle joint; first funicle joint the longest, joint two very slightly longer than three, joint three one and one-half times as long as broad and approximately three-fifths the length of the first; club short, pointed ovate, obscurely three-jointed, the first suture distinct but shallow, the second suture subobsolete; thorax finely lineolated above, the mesoscutum with a distinct complete median groove, scutellum without a median groove, but with the dorso-lateral grooves complete and distinct; propodeum very short, without any carinæ and very faintly reticulately sculptured, nearly smooth; mesopleura practically smooth, the prepectus distinctly shagreened; basal joint of hind tarsi a little shorter or no longer than the second joint; submarginal vein of the forewing with at least four or five bristles above; abdomen about one and two-thirds times as long as head and thorax, as broad as the thorax and pointed at apex, the tergites very faintly sculptured. Head, thorax, abdomen, and all femora brownish-black; flagellum brownish; scape, pedicel, all tibiæ and tarsi pale testaceous; an obscure transverse spot in front of the anterior ocellus, also, pale; metanotum medially, more or less testaceous; wings hyaline, the venation testaceous.

Male. Length 1.3 mm. Scape of antenna a little thicker than the pedicel and about twice as long; pedicel conical, a little longer than thick; ring-joints very small, the number not discernible; funicle four-jointed, the first joint as broad as long, somewhat shorter and broader than the pedicel, second about one and two-thirds the length of the first; third and fourth joints equal and each a little longer than the second; club plainly three-jointed, about as long as the two preceding funicle joints combined, the apical joint produced at apex into a sharp point; each of the four funicle joints with a half-whorl of hairs above

near the base, the hairs three to four times as long as the joint bearing them; basal joint of club with a half-whorl of similar long hairs above near middle of joint and another half-whorl beneath and a little more basad; abdomen not longer than the head and thorax, narrower than the thorax and not pointed at apex. Antennæ entirely pale testaceous; abdomen with a large pale, nearly white spot at base above. Other characters as in the female.

Type locality, Tempe, Arizona. Type, Cat. No. 22300, U. S. Nat. Mus.

Three specimens, one female and two males, reared by Mr. Wildermuth from galls of the alfalfa gall midge, *Asphondylia websteri* Felt, under Webster No. 7268, Tempe No. 2264. Also two females and two males reared by E. G. Smyth from the same source. Antenna of female paratype and male allotype on a slide.

The host relations of this species are unknown to the writer. It may be either a primary or secondary parasite of *Asphondylia* or it may possibly have been parasitic upon *Bruchophagus funebris*, specimens of which were reared from the same lot of galls.

Tetrastichus bruchophagi Gahan.

Specimens of this species were received from Mr. Wildermuth under Tempe No. 2264, having been reared together with several other species of Hymenoptera, including *Bruchophagus funebris*, from galls of *Asphondylia websteri* Felt, collected in the field and placed in vials for rearing parasites. The species is known to be a primary parasite of *Bruchophagus funebris* and may have been present in the *Asphondylia* gall in this role. On the other hand, it is not unlikely that this species, like *Trimeromicrus maculatus*, may have developed as a secondary parasite of *Asphondylia* using some one of the primary parasites of the Cecidomyid as host.

Paragaleospomyia gallicola, new species.

It is very close to *P. eja* Girault, but differs in having the abdomen more slender, and the hind tibiæ black only on the apical half.

Female. Length 2 mm. Head, viewed from in front, slightly broader than long, the ventral margin nearly straight, cheeks slightly convex in profile; antennal depression deep and broad with a shallow subquadrate extension below the base of antennæ; ocelli in an obtuse triangle, the postocellar line about twice the ocellocular; face and cheeks

finely and weakly reticulated, the frons and vertex with similar but stronger sculpture; antennæ separated at base by a distance about equal to that between the base of antenna and the eye margin; scape slender, flattened outwardly; pedicel three times as long as thick, about equal in length to the first funicle joint and the ring-joints combined; four distinct, transverse, ring-joints; funicle three-jointed, the first joint the longest and about twice as long as thick; second joint distinctly, though not a great deal longer than broad and a little longer than the third; third joint subquadrate; club solid, and very slightly longer than the two preceding funicle joints combined; pronotum and mesoscutum strongly shagreened, parapsidal grooves deep, praescutum without trace of a median groove; scutellum more weakly sculptured than the mesoscutum, lineolate-reticulate with the paired dorsal grooves distinct, but without a median groove; propodeum rather long, distinctly, though not deeply, reticulate-punctate, slightly shining, with a distinct median carina; mesepisternum and prepectus sculptured like the mesoscutum; mesepimeron mostly polished, its dorso-posterior margin reticulated; hind coxæ strongly reticulate-punctate; abdomen as long as the head and thorax, slightly narrower than the thorax, pointed at apex, the first and basal half of second tergites polished, the apical half of second and the following tergites distinctly reticulate-punctate; second tergite a little shorter than the first; third and fourth large, subequal, and each about as long as the first. Black; flagellum brownish testaceous; scape, anterior tibiæ, basal half and narrow apical portion of median and hind tibiæ testaceous; all tarsi pale yellowish, the apical joint black; wings hyaline, venation testaceous.

Male. Length 1.25 mm. Antennal scape with a slight keel-like expansion on apical half beneath; three transverse ring-joints; funicle four-jointed, the first joint small and subquadrate or very slightly broader than long, second joint one and one-half times as long as broad, third very slightly longer than broad, the fourth quadrate; club solid, nearly as long as the three preceding funicle joints and distinctly thicker than the funicle; abdomen subpetiolate, about as long as the thorax, the first tergite a little longer than the second, smooth; second and third tergites sculptured, the third about twice as long as the second, tergites beyond the third very short. Scape black, flagellum testaceous. Otherwise like the female.

Type locality, Tempe, Arizona. Type, Cat. No. 22301, U. S. Nat. Mus.

Two females and six males reared by V. L. Wildermuth from Cecidomyid stem-galls on *Pluchea borealis* and recorded under Tempe No. 2742.

Galeopsomopsis transcarinatus, new species.

Very similar to *G. multisulcatus* Girault, but may be distinguished by the fact that the first funicle joint is the longest of the funicle joints, the true metanotum is smaller, not quite so strongly sculptured, with the

median carina less strongly developed, the submarginal vein has four to six erect hairs above instead of two, and the propodeum is slightly different.

Female. Length 2 mm. Antennal pedicel conical, a little shorter than the first funicle joint; ring-joints transverse and apparently three in number; first joint of funicle slightly longer than the second and fully twice as long as thick, second a little longer than the third, the latter ovoid and not one and one-half times as long as broad; club not quite as long as two preceding joints, ovate, distinctly three-jointed and terminating in a short spine, the joints subequal in length, but joints two and three narrowing rapidly toward apex; antennal depression deep and triangular; malar furrow basally represented by a deep rounded fovea; ocelli large, the lateral ocellus separated from the eye margin by distinctly less than the long diameter of an ocellus; a deep groove runs anteriorly from each lateral ocellus, the two grooves converging in front of the anterior ocellus; face laterad of the antennal depression and the vertex strongly sculptured; mesoscutum and scutellum lineolately sculptured; praescutum with a faintly indicated non-impressed median line, and two or three rows of pimple-like rugosities along the margins of parapsidal grooves; scutellum apparently with only an apical pair of bristles; grooves of the scutellum not deeply impressed, the sublateral pair with a few pimple-like rugosities similar to those of praescutum; metanotum faintly sculptured with an indistinct median carina; propodeum strongly sculptured all over, with a distinct median longitudinal carina and a strong transverse carina, which is more or less interrupted medially; the surface in front of the transverse carina shagreened; behind the transverse carina also shagreened but divided by several more or less distinct longitudinal carinæ; marginal vein longer than the submarginal, the stigmal about one-third the marginal and scarcely at all thickened at apex; abdomen subsessile, conic-ovate, and strongly shagreened above. Color metallic blue-green; wings hyaline; antennæ, tegulæ, wing veins and the legs for the most part pale testaceous; all coxæ concolorous with the thorax, all femora; except apically, blackish brown.

Male. Length 1.6 mm. Scape very slightly expanded beneath on apical two-thirds; apparently but one ring-joint, and this very obscure; funicle five-jointed, the first funicle joint very slightly shorter than the pedicel and a little longer than broad; second joint about one and one-half times the first; third and fourth joints subequal and twice as long as the first; fifth funicle joint longer than the first, but shorter than the second; all funicle joints narrower at apex than base, and bearing near base above a half-whorl of hairs approximately twice as long as the joints; the fifth joint has in addition a half-whorl beneath and nearer the base than the dorsal whorl which is located near the middle of segment; club two-jointed, slender, the joints subequal in length, the apical one tapering to a sharp point at apex; the basal joint of club is provided with a whorl of long hairs which are not as long as those of the funicle joints; ocelli large and narrowly separated from the eye

margin; propodeum with the transverse carina weak, especially medially; abdomen not longer than the thorax, parallel-sided or nearly, not depressed above and much narrower than the thorax. Otherwise like the female.

Type locality, Tempe, Arizona. Type, Cat. No. 22303, U. S. Nat. Mus.

Host, *Asphondylia websteri* Felt.

Type, allotype and six paratypes reared by Mr. V. L. Wildermuth from galls of the alfalfa midge and recorded under Webster No. 7268, Tempe No. 2251. Also ten specimens with the same data under Tempe No. 2264. All specimens on card points; antennæ from a female and a male paratype mounted on a slide.

Whether the species is a primary or secondary parasite of *Asphondylia* the writer is unable to state.

THE PROGRESS OF SCOLIA MANILÆ ASHM. IN HAWAII.

By F. Muir,
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In a former article* the introduction of *Scolia manilæ* into, and its establishment in, the Hawaiian Islands was described. At that time the wasp was well established but its host, *Anomala orientalis*, was very abundant and doing great damage.

As an example of the difference between the conditions then and now the following comparisons are of interest. In 1917 from one-twentieth of an acre, 3500 *Anomala* grubs were collected from between the rows without digging around the roots of the sugar cane. Now in the same locality but over a larger area only four grubs could be found by following the plow and searching. In another locality 104 eggs, 181 grubs, 7 pupæ and 10 adults were collected from around the roots of one stool of sugar cane, now in the same locality one can only find a stray specimen after considerable search.

The parasite has extended its range beyond the area infested by *Anomala orientalis*, and is now working on *Adoretus tenuimaculatus*, a beetle common all over the archipelago.

The reduction of the *Anomala* is due solely to the action of the *Scolia* as all other factors are the same as previous to the introduction of the *Scolia*, when the *Anomala* was constantly increasing and spreading.

The phenomenal reduction of *A. orientalis* has raised the question as to the possibility of its eventual extinction. Should the *Scolia* maintain itself upon the *Adoretus* but show a great predilection for the *Anomala* such a thing may happen. The final outcome is being watched with great interest.

*Ann. Ent. Soc. Am., X, p. 207 (1917).

NOTICE OF PROPOSED AMENDMENT TO THE CONSTITUTION OF THE ENTOMOLOGICAL SOCIETY OF AMERICA.

By Wm. A. Riley.

Article V—Sec. 3. The six additional members of the Executive Committee shall be elected for a term of three years, two members retiring each year. The six members first elected under this rule shall determine by lot their respective terms of service.